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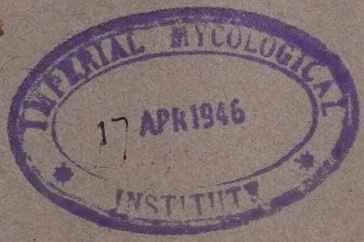

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The Journal of

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Editor : D. B. ADAM, B.Agr.Sc. **Business Manager :** C. S. PIPER, D.Sc.
Address : Waite Institute, Private Mail Bag, Adelaide, S.A.

Vol. 11, No. 3 SEPTEMBER, 1945

The Fourth Report of the Rural Reconstruction Commission

FINANCIAL AND ECONOMIC RECONSTRUCTION OF FARMS.

Having laid down in its Third Report the broad principles which should govern farm settlement in the future, the Commission next turns its attention to the problem of farms " which are financially and agriculturally unsatisfactory " (R.p. 3).* In other words, having blue-printed the future of agriculture it turns to clean up some of the present financial problems.

A brave task, indeed, for most persons who had any knowledge of Australian agriculture before the war will agree that the task is little short of analysing the financial difficulties of most farm operators in several Australian primary industries. Those with real financial problems were the majority and only the minority would be unconcerned with the difficulties discussed in this report. To back this rather gloomy statement one might quote the N.S.W. Council of Primary Producers Associations (R.p.3) : " In the opinion of this Bureau the following comments are sound :

(*a*) Wheat-growers—position very unsatisfactory. It is estimated from local knowledge that 25 per cent. may be in a satisfactory condition, 25 per cent. are battling and 50 per cent. near enough to bankrupt and just living on the land.

(*b*) Dairy-farmers—as a class they are in a very unsatisfactory financial position . . . "

Relief to this gloomy picture is provided by the trading banks, for their evidence, given *in camera*, " was unanimous to the effect that the general financial position of their farm clients had improved considerably during the war—that relatively few were in serious difficulties " (R.p.5). If Australian agriculture can become solvent only in the artificial conditions created by a war, it certainly is in need of root and branch financial readjustment.

In the analysis of the financial difficulties of farms and in the criticism of what in the past has been " farm relief ", the Report is complete and penetrating ; one cannot feel though, that the remedies proposed are always completely realistic because they depend almost entirely on new administrative machinery. If the particular institutions proposed by the Commission are not set up, one fears that the brilliant analysis of financial difficulties presented by the Commission will rest securely in

* References throughout to the Report are given as (R.p. —).

some pigeon-hole. Further generalization though must, in all fairness, follow from a detailed consideration of the Report.

Laissez-faire Policy Assessed.

Some farmers, then, are in financial difficulties. What should be done ? The Commission first, quite rightly, disposes of the *laissez-faire* school who would argue that the State should stand aside and allow " the normal course of economic events " to solve the problem of eliminating the " unfinancial, the uneconomic and unfit ". (R.p.6). (Persons who argue in this way still exist, because I know one !) Three charges they hurl at the heads of the *laissez-faire* school :

(*a*) Not all farmers are in economic difficulties because of individual failings—in fact most are the victims of forces over which they have no control.

(*b*) Such forces are not to be accounted ordinary business risks because often whole districts are affected. Such a situation cannot be left to the free play of economic forces ; in fact (as the Commission points out) it usually results in the opposite ; governments rush in with " ill-devised relief schemes which are costly, and being largely palliatives, will not achieve a positive result " (R.p.7).

(*c*) The psychological effects of a *laissez-faire* policy are, of course, demoralizing. Farmers either decide they can't pay, or won't pay, or get to work and over-crop or over-stock to the permanent detriment of the soil. This last consideration alone is sufficient to eliminate the everyone-for-himself-and-the-devil-take-the-hindmost-school—the devil *will* take the hindmost, but only after that unfortunate has placed his property in such a state that most of the topsoil will have been washed or blown away.

Bounties and Subsidies.

The Commission next turns to subsidies and bounties and finds them wanting ; and since almost every primary industry now has a bounty or subsidy and most are clamouring for more, it is attacking a very popular panacea for all the economic ills of agriculture.

It is pointed out that bounties and subsidies operate indiscriminately, in fact the producer who is " well-in " usually gets more than the marginal farmer in whose interests vociferous parties claim these financial aids. And, as the Commission points out, artificial prices are a vital concern to the consumer, but his interests are seldom consulted in the matter. Finally, too often bounties and the like are used to prop up inefficient industries and they are, in any case, soon passed on into land values. The State, however, has been expected to step in and provide large sums of money to support this and that industry—but most efforts of the State to enforce standards of efficiency are reckoned inroads upon that elastic and vague ideal known as freedom. The spectacle of Australian agriculture demanding more and more State support but complete and irresponsible individual " freedom " is one of the economic paradoxes of the age ! More to that later.

Permanent Reconstruction Machinery to Treat Individual Cases.

As a contrast to bounties and subsidies the Commission recommends (and this is the mainstay of the whole report) *permanent reconstruction machinery* capable of readjusting unsatisfactory farms *on an individual basis.*

Although some of the economic ills being tackled are very general, the Commission sets great store by individual adjustment. " The Australian farming industry is made up of a large number of individual business enterprises, no two of which are exactly alike. Each has its own location, its own debt structure and its own operator with his individual characteristics . . . the Commission therefore concludes that, as the factors governing success in farming enterprises vary so much

in individual cases, plans to overcome unsatisfactory settlement must be framed on the basis of individual examination of each enterprise." (R.P.10). It goes on to recommend that where investigation shows that a man is not suited to be a farmer no assistance should be offered to keep him on the land. One must support this controlled dose of *laissez-faire* medicine.

Financial Solvency and Revenue Stability.

When the financial requirements of a successful farm business are analysed the report avoids the errors often made by the originators of farm relief schemes by being aware of the difference between capital and revenue. A farmer needs financial solvency (defined as being the possession by the farmer of an equity of at least 30 per cent. of the realizable value of the farm assets) (R.p.12). And he needs revenue stability, defined as the " expectation of an income which will cover commitments and leave an adequate margin to permit of a reasonable standard of living " (R.p.12).

At this point the Commission drags in (rather by the heels) the question of the size of the farm and the treatment of the farm which is too small. In any situation there is an optimum sized farm, and farms which are appreciably smaller are likely to be uneconomic (a cause of erosion). When a farm is too small in the first place, or becomes too small because conditions (and therefore the optimum size) change, the readjustment is very difficult. To bolster up the uneconomic unit with State funds is to shirk the issue—to wait for the unfortunate holder to walk off and the farm be bought by a neighbour is a policy of despair. In any case before he walks off the farmer would probably permanently impoverish the soil. This problem obviously cannot be solved within the limits of *laissez-faire* economics, and the Commission recommends compulsory acquisition by the Crown of farms, which on investigation prove to be uneconomic. *If this recommendation alone is enforced, Australian agriculture will materially benefit, and much valuable soil will be saved.*

Revenue Instability.

Returning to its main argument, the Commission analyses the chief causes of revenue instability which lend themselves to readjustment. They list :

(*a*) Heavy debt repayments. A farmer's total debt may be reasonable, given his enterprise, but if for some reason the debt is a short-term one his annual repayments may be too high for his farm to carry.

(*b*) Insufficient development. Agriculture in most new countries is usually under-capitalized, yet too heavily burdened with debt ! The reason for this paradox probably lies in the high rate of interest general in new countries.

(*c*) Lack of sufficient or proper equipment.

(*d*) Faulty farm practices. Here the Commission makes a strong point when it points out that demonstration and education are not enough to overcome the many prevailing faults in agricultural methods ; a reconstruction authority needs power to " grant credit assistance where such is necessary to enable desirable changes to be carried out " (R.p.15). Financial difficulties often prevent farmers making changes and are the basic cause of soil-depleting practices.

(*e*) Over-capitalization.

The consideration of this list of factors leads to the obvious yet vitally important conclusion that " reconstruction of the affairs of embarrassed farmers is not just a matter of making some adjustments in finances. Technical education and guidance and the adjustment of agricultural practices and organization on the farms are of first importance. It follows that any organization set up to overcome the problems of financially embarrassed farmers must be capable of applying to those problems intelligent agricultural analysis . . . The ideal organization would be one which combined the financial and agricultural approaches " (R.P.16).

Investigation and Education.

As a corollary to its insistence on an individual approach the Commission sets out in some detail the type of investigation to be conducted. One recommendation is of particular interest, viz.: the investigator must use " long-term averages of yields, prices and costs when estimating revenue expectations and avoid estimates based on assumptions for which there is no proved basis " (R.p.17).

Long-term averages of yields, prices and costs are very necessary data, but someone will have to start immediately to provide facilities for more research in agricultural economics if they are to be ascertained. Although the Commission is not dealing with education in this report, one feels it should somewhere have underlined the neglect, especially by universities, of agricultural economics.

Some Past Schemes.

Various relief schemes used in the past are then surveyed—and in the main dismissed as expensive palliatives. *Forbearance and postponement of obligation* the Commission rejects except for the most temporary setbacks. In general the assistance granted is too sweeping and probably does nothing to remove the basic cause of the difficulty. One says probably, because the foregoing of rent on land which is left idle, or planted with pasture following overcropping for cereals, may be sound policy. The use of *short term credit*, provided by the State to assist farmers over droughts and other calamities, is not encouraged by the Commission; in fact it argues that the State should " retire gradually from the use of public moneys for this form of activity and concentrate instead on the maintenance with sufficient financial resources of

(1) a national agricultural credit service for normal agricultural credit; and
(2) general adjustment machinery to deal with necessitous cases which are shown to be outside the scope of the general credit service " (R.p.22).

Here is one of the points where one feels the Commission is being a little unreal. It is argued that a farmer who wants drought relief can get credit, if his long-term outlook is good, from a commercial institution or, if such institutions are nervous, from the National Credit Service. They recommend, on the other hand, that the farmer whose long-term outlook is bad should not get relief—but be properly cured. Hence both cases are taken care of and there is no need for public grants.

This argument might give trouble at two points. If the National Credit Service is not established, the condemnation of the use of public funds is considerably weakened. Moreover, in a general drought (like that of 1943-44) it would be well nigh impossible to subject each farm to that individual analysis, so strongly recommended by the Commission, to find out which have good and which have bad long-term outlooks. If it is necessary for the State to bear some of the risks of the acts of God (and I believe that this will be necessary) there is much to commend the new principle introduced in public finance this year by South Australia. A large sum paid out as drought relief was charged against revenue, as being non-productive expenditure and not part of a loan account. Some further implications of the State's bearing risks will be pointed out in the concluding paragraphs.

The Commission then considers *waiving Crown dues* and believes this should seldom be necessary, mainly because no one owing Crown dues should be allowed to get into arrears without a thorough investigation to see if fundamental adjustments are necessary. Next *moratoria*, virtually an extension of time to pay, are described—and also found wanting. This method of financial readjustment is too general and too superficial to bear close analysis. The whole attitude towards financial readjustment has been to provide temporary relief in the hope that the farmer will gradually make a recovery. Framers of moratoria hoped for such recoveries, whereas no economy really makes a recovery, it moves on to a new situation.

The Commission brings the same healthy attitude of insisting on attention to the production prospects of a farmer's business as well as his debts to a criticism of

the Commonwealth : State Debt Adjustment Scheme of 1934. Much money was advanced or granted under this scheme, but little real adjustment was attempted. The Commission, by the way, have an almost naive faith in their lords and master the Commonwealth, when they suggest that " a much greater measure of success (for this scheme) might have been achieved if

(1) more attention had been paid . . . to the original plan ;
(2) the Commonwealth had taken a more active part . . . ;
(3) the Commonwealth had policed the various administrations . . . ;
(4) a Commonwealth liaison officer had been made available to assist and advise the States' Administration . . . " (R.p.36).

Next, in its survey of relief schemes, the Commission tells the sad story of the *marginal wheat areas* . . . " These settlements are an outstanding example of the huge cost in wasted capital, in human effort, in land depreciation and in public relief that can come from faulty settlement planning and from delay in applying fundamental relief measures " (R.p.37). Governments were long in really tackling this problem, although money was poured out in millions. " So long as all this assistance was forthcoming the necessity of applying positive relief measures was pushed into the background " (R.p.38). In other words the same old story of financing basically uneconomic farms.

From a short survey of Acts in Victoria, N.S.W. and W.A. designed to effect financial readjustments one important consideration emerges. Of the Victorian Closer Settlement Commission it is recorded that " the greatest single factor contributing to the success of (its) efforts was the action taken by the Victorian Government in investing the Commission with autonomous power to carry out such adjustments as it considered necessary " (R.p.41). In agriculture, as in other parts of most economies, the State has to undertake new responsibilities, and new administrative organs must be set up to handle these new responsibilities. Such administrative organs must have as much autonomy as possible. The usual government department set-up is unsuitable for most twentieth century governmental activities.

Having critically analysed the efforts made to date to readjust farmers, the Commission sets out its solution, keeping very firmly in mind the two tenets : individual approach designed to remove basic causes of financial trouble and permanent reconstruction machinery.

Rural Bank and Farm Adjustment Board.

They recommend that in each State there should be set up a " rural bank operating in two departments, namely a rural bank department and a government agency department " (R.p.50). The Rural Bank Department is to provide normal rural banking facilities at " reasonably competitive rates of interest ". The Government Agency Department is to be the instrument (but not the instigator) of reconstruction activities. It will

" (*a*) collect existing government loans and land dues ; and
(*b*) operate an administrative and financial service for the reconstruction of unsatisfactory settlement " (R.p.65).

The actual decisions on financial reconstruction are to be made by another body, the Farm Adjustment Board, which, it is suggested, should consist of three members, representative of the Rural Bank, the Lands Department and the Agricultural Department. This board is the key body, for " its responsibilities would relate chiefly to decisions affecting the compulsory adjustment of debts, the reconstruction or elimination of uneconomic farms and the removal of unsatisfactory farmers. The board would be solely an adjudicating body ; the actual administration being carried out by the bank " (R.p.65). In view of its wide functions one is a little surprised that the Commission recommends that board members receive no fees !

Farmers in difficulties, then, would have their affairs carefully investigated by the Government Agency Section of the Bank, which, *with the consent of the Farm Adjustment Board* (this phrase is always italicized in the Report) " can grant a stay order staying proceedings against the farmer or his estate " (R.p.53). After this stage is reached the farmer operates the property virtually to the instructions of the bank and this body, with the consent of the Farm Adjustment Board, has the widest powers to readjust debts, acquire the land to change the size of holding, waive Crown dues, or take any other steps which investigation reveals are necessary for fundamental reconstruction, financial or agricultural. To list in detail the powers of the Bank acting as administrative agent for the Adjustment Board would take us too deeply into matters of pure administration, but some of its responsibilities would include :

(1) Grant loans to allottees of land under settlement schemes, to persons carrying on farming activities for the purpose of effecting a settlement of existing debts and to persons intending to carry on industries immediately associated with rural pursuits. These loans may be made at concessional rates of interest as determined by the Treasury.

(2) Arrange the suspension, adjustment and settlement of farmers' debts by compulsory arrangements. As part of this, of course, the Bank would be faced with the management and administration of estates.

(3) Carrying out almost any adjustment relating to Crown debts, e.g.,

" (*a*) waive the payment in whole or in part of any such moneys ;

(*b*) direct that interest be not charged upon the whole or any part of such debt and that the rate of interest payable thereon be reduced ;

(*c*) fix the terms of payment of . . . such debt " (R.p.58).

(*d*) Resume uneconomic holdings and arrange compensation.

In general the Bank, with the consent of the Farm Adjustment Board, can take any actions which an intelligent investigation by financial and agricultural experts shows to be necessary. With such wide powers it will certainly need to be " resolute in its decisions and efficient in its general organization " (R.p.67).

General Comments.

Such, then, is an outline of the report. We can now attempt a general appraisal. In such an appraisal one must resist certain criticisms because the report is one of a series and not complete in itself. Thus a discussion of how the Bank will scale down farm debts, without a word on preventing land values exceeding long-term yield value, seems incomplete. However, in their third report (p. 127) the Commission has promised a later statement on land values and their control. Further, as was mentioned earlier, Australia has not the economists trained in agriculture and the agriculturalists trained in economics (nor one might add the statistical data) to attempt some of the investigations which the Commission recommends. One feels sure, though, that this point will not be missed in the promised report on rural education.

In general one must applaud the insistence on permanent reconstruction machinery aiming at fundamental adjustments and the individual approach. But will the latter always be possible ? I mentioned the drought and frost, which is general ; and following such an occurrence it might be desirable for general action. Further, whole agricultural industries can be affected by, e.g., changes in the world position of demand for or supply of a particular product. Once again it might be desirable to investigate thoroughly each farm before setting it off on a new tack suited to its owner, soil, rainfall, etc. ; yet such an individual approach might not be practicable when whole districts demand attention.

It could be argued, of course, that if the principles of land settlement outlined in the third report were followed, all that the machinery of the fourth report has to do is to whip up the stragglers. However, for one thing there are going to be more stragglers than regulars for a start, and for another, unless agriculture is to remain

completely static, important general changes not yet obvious even to the expert will occur. To cope with such change without the capital losses and low morale which usually accompany them might be beyond the capacity of the machinery proposed if the individual approach is strictly maintained.

One wonders a little just how this rural bank will fit into the existing set-up of agricultural finance—and doubts if it will fit in quickly enough to solve the important problem posed for it. Since it is to compete on not unfair terms with private lending institutions, its customers will be attracted either because of the excellence of its service (and to establish such a reputation takes time) or because of the assistance which the Government Agency Department can give. In other words, there is a grave danger of the whole set-up being regarded as a relief organisation to be turned to only as a last resort : a bank for the doubtful accounts alone.

If this be the attitude of farmers, much of the value of the scheme will be lost ; on many occasions the time for readjustment is before things are desperate. As an example, one might instance the question of soil depletion and erosion following over-cropping or over-stocking. If the farm operator carries on with his ordinary method of finance and his unsound practices as long as he can and then casts himself, as a last resort, on the Farm Adjustment Board, the damage will have been done. Whether or not this criticism is valid depends on the reactions of the rural community generally to the proposed institutions ; in presenting the case for the Bank, if it be established, everything should be done to avoid it being regarded as one tiny jump ahead of the bankruptcy court.

The dismissal of bounties, subsidies and artificial prices by the Commission is in keeping with its approach, yet here they are probably crying for the moon. Australia is a high cost country and yet an exporter ; therefore it has found that certain industries need bounties and the like. One is aware that protection for primary industries has rather run riot in Australia, with the result that inefficient methods are sheltered and the price of products to the consumer are above what they should be ; nevertheless it is difficult to imagine, for example, the sugar or dairying industries deprived of them altogether.

In answer to this criticism, though, it must be admitted that the Commission in this report, is concerned only with assisting uneconomic farms, and not whole industries. However, its condemnation of subsidies might have been more qualified.

One last general point. As I mentioned earlier, governments in Australia have poured out millions of pounds in all manner of relief schemes, and have taxed the community directly and indirectly very heavily to assist the primary industries, yet the farm operator still claims to be a rugged individualist who is " free " to work his property just as he pleases. The plain fact of the matter is that the risks of farming are too great for most individual farmers to bear and therefore some of the risks have to be transferred to the shoulders of the State. In the last analysis, that is the result of readjustment schemes. But here is the rub : if the State is to bear some of the risk, it must share in control ; it must be able to exercise a general supervision over agricultural practices and have a remedy against those farmers who refuse to respond. The machinery proposed in this report makes provision for this in the case of farmers who have need of readjustment, one would like to see the lesson driven home to farm operators in general.

The Commission in this report has done a great service to Australian agriculture in showing so clearly what is involved in " handling farms which are financially and agriculturally unsatisfactory " (R.p.3). It is to be hoped that the excellence of their analysis is not lost sight of even if the machinery proposed is not set up. With at least seven governments in the field, each with existing organisations in being, the likelihood of anyone implementing the exact administrative scheme recommended seems small. It will be a tragedy if in shelving the idea of a Rural Bank, Government Agency Department and a Farm Adjustment Board, Australia shelves this whole report. A very fine baby will have been thrown out with the bath-water.

A. M. RAMSAY.

Reports on Regional Boundaries in Australia

The general meeting of the A.I.A.S. last February raised the question of regionalisation of agriculture as to research, extension and development. The Federal Council of the Institute has referred to all Branches for discussion the problem of assisting fuller development of rural areas by regionalisation into units capable of economic and stable progress.

At the end of March, 1944, a conference of State and Commonwealth officers at Canberra agreed that the Premiers of all States should be asked to discuss the question of regional planning. The Premiers Conference in October, 1944, passed a resolution that " The States which have not already taken action will aim at defining regional subdivisions for purposes of development and decentralisation . . . " Meanwhile the N.S.W. Government had moved in advance of this proposal by setting up a Regional Boundaries Committee in December, 1943, which had already presented its report before the March conference. Victoria followed with a similar committee in April, 1944, which reported in the following December. As far as is known reports have not been issued by the remaining States.

N.S.W. Report, March, 1944.

The objective of the N.S.W. Regional Boundaries Committee was simply to design a subdivision of the State into regional areas. The terms of reference stated that " It is proposed to set in hand a regional survey of the resources of the State with a view to facilitating planned development notably in connexion with housing and public works, but also to provide a basis for investigation of the employment structure and decentralisation of primary and secondary industry ". The report of the Committee consists of a statement explaining its findings and a map showing the 17 regional units, supported by 36 individual maps, published separately, of various features affecting the subdivision. The Committee began by defining its conception of a region as a unit that " should have a broad measure of economic and social unity and of community of interest ". The regions were made as large and inclusive as possible, leaving the way open to further subdivision rather than aggregation. Geographic considerations played a large part in the delineation of boundaries. The future trends in development were also envisaged, although apparently little constructive assistance was forthcoming from outside sources to clarify the picture. Factual information for potentiality-planning in primary industry was found to be insufficient, a conclusion which should prompt activity in this important aspect of agricultural progress.

The report recommends 17 regions in the Eastern and Central Divisions of the State excluding the Western Division due to its sparse population and the unlikelihood of expanding production, except in odd portions following any irrigation development. There is, as would be expected, considerable disparity in density of population, the extent and the production of the various regions. Those fronting Victoria are small in wealth and population and are considered as incomplete in themselves, having strong community of interest with regions across the Murray river. The one and a half million population of the Sydney region dominates the State and from the nature of the centralised transport system, country development everywhere except in the border areas must cause this region to become even more dominant.

The coastal belt is divided into seven regions from north to south as follows: Richmond-Tweed, Clarence, Oxley, Newcastle, Sydney, Illawarra, Monaro and Southern Tablelands. The tablelands belt is represented by Upper Hunter and Southern Tableland, while New England on the north extends as far west as Moree, and Mitchell in the centre to Orange. The Central Division is split into six regions, Namoi, Macquarie, Lachlan, Murrumbidgee and Upper and Central Murray along

the Victorian border. The population of the non-industrial regions varies from 26,000 in Central Murray to 114,000 in Mitchell, 10 out of the 17 units having between 50,000 and 100,000. In size the variation is equally great from Illawarra, the smallest, to Namoi, the largest, which reaches over 23,000 square miles.

The report reviews the material presented in the 36 supporting maps. There is some complaint of the lack of soil data as a fundamental feature for planning purposes. Apart from the irrigation areas, N.S.W. has not made any concerted attempt to carry out soil survey investigations, and it is futile to quote American and Russian activities in such work for an Australian comparison. Maps illustrating the character and distribution of the sheep population, the dairying industry, of livestock generally, of wheat, and the total agricultural production of rural areas have been compiled. Timber and fishery resources are shown separately. For some time to come it was concluded that agricultural usage would remain essentially unchanged. The population aspect was viewed optimistically in country regions with the conclusion that while the Central Division regions have little prospect of marked increases, the slopes and tableland provided erosion is controlled, should show a " substantial increase " and the coastal belt a " very considerable increase ".

Since the publication of the report, a series of maps illustrating the major features characterising the individual regions have been issued by the Reconstruction and Development Division of the Premier's Department. These include climatic maps with homoclimes, geological maps, maps showing communications and amenities and, in one instance, a soil map. At the present time sets have appeared for the following regions : Macquarie, Richmond-Tweed, Namoi, Clarence, Murrumbidgee, Mitchell, Lachlan, Central Murray and Upper Murray.

This report of the N.S.W. Committee in preparing a basis on which the development of primary and secondary industry could be studied marked a good step forward. It is significant that the Committee stated clearly that there was a lack of potentiality data which would have served them in reviewing possible developments within specific areas. This type of research requires expert workers in various phases of agriculture, forestry, soils and engineering, organised as a team. The soil factor is of prime importance and interpretation of climatic data turns on it partly. A great deal of work in agro-climatology is also called for and perhaps the statement that " climatic conditions in N.S.W. are well-known " should be qualified if land potentialities are in question.

Victorian Report, December, 1944.

The Report of the Victorian Regional Boundaries Committee covers similar ground to the N.S.W. statement and follows the same concept. " A region ", it stated, " has been defined as an area of land which has natural geographic boundaries and which is united by the characteristics of its natural resources and common social and economic interests." The Committee took six criteria as guiding principles in delineating regions. Briefly, these were that an area should be preferably a physiographic unit ; it should be large enough to afford balance in development, submerge sectional interests and possess sufficient resources for an increased population ; it should include entire problem units and not " cut across a unified pattern of development " ; it should justify development of transport and public utilities ; it should have such community of interest as to encourage a regional consciousness and finally, it should lend itself to efficient administration. While no area was thought to reach such an ideal, the Committee evolved a working subdivision of the State into 13 regions.

The bases of the determination were listed by the Committee as follows : (*a*) topography, (*b*) distribution of population, (*c*) communities of interest and mutual problems, (*d*) climate, (*e*) soils and geology, (*f*) land utilisation and productivity, (*g*) mineral resources, (*h*) water resources, (*i*) power resources, (*j*) secondary industries, (*k*) transport services, (*l*) amenities and community facilities. It is of interest to

note the apparent importance ascribed to primary industry and associated factors in regional development. Victoria, as N.S.W., was forced to admit the inadequacy of certain information of which the soil data was a significant deficiency, and it is encouraging to note the clear view being widely taken on the necessity for more detail on soil resources as a basic step in planning.

The 13 regions are named as follows, with an indication of their location by reference to included towns or geographic features: (1) Port Phillip (Melbourne), (2) Barwon (Geelong and west of Port Phillip), (3) Corangamite (Colac-Warrnambool), (4) Glenelg (Portland-Ararat), (5) Central Highlands (Ballarat), (6) Gippsland (east of Port Phillip), (7) East Gippsland (eastern portion of State—Sale), (8) Upper Murray (Albury), (9) Goulburn, and (10) Upper Goulburn (dividing the Goulburn River basin), (11) Loddon (Bendigo-Kerang), (12) Wimmera (Stawell-Nhill), (13) Mallee (north-west portion of State). It was proposed that although subdivision of these regions may be desirable for certain types of investigation for development, the tendency should be to keep them in large units and seek interregional cooperation. Victoria also recognised the obvious connexion of regions on either side of the Murray River, such as was envisaged in the formation of the Murray Valley Development League in 1944. It may be noted that the boundaries of Upper Murray regions of Victoria and N.S.W. coincide, but that Central Murray, N.S.W., extends across the Goulburn, Loddon and part of Mallee regions of Victoria.

The areas of the Victorian regions are naturally smaller than those of N.S.W., but the population figures are much the same, with Melbourne dominating the scene on this as well as in the matter of transport.

An excellent summary of the main features of the various regions is tabulated with the report. In this table the physical features (topographic and geographic) and natural resources such as soils, forests and minerals are given in the first column; population (rural and urban) and the means of livelihood in primary and secondary industry in the second column, and in the third, transport, water supply, power and welfare are summarised. The data bring out the actual and, as far as possible, give a lead to potential developments. Statistical information is available by counties, but apparently has not been compiled for the designed regions.

A full series of 32 maps of Victoria showing known resources and features is appended to the report. One group of maps illustrates topography, rainfall and climatic data, while a second shows water resources and the utilisation of water resources, the soil types on a broad basis, the utilisation of the land, and soil erosion. A third group deals with agriculture and livestock, showing separately areas under wheat, oats, barley, fruit, potatoes and maize, gross areas under cultivation, the distribution of sheep, of dairy cows, of other cattle, and of livestock generally. A fourth group covers the non-agricultural primary resources of forests and economic minerals. A fifth group illustrates transport facilities, electricity supply, farm power, town public utilities and the distribution of town and country population.

The maps cover the whole State, and much of the material is shown on a county basis. It would have been of greater value in assessing the regional subdivisions if the boundaries of the proposed regions had been shown boldly on these plans, even if it were not possible to show the aggregate statistics for each, instead of the counties. Another point requiring explanation is the use of the first, second and third class in showing intensity of areas under wheat or sheep numbers.

It is to be hoped that the remaining four States will quickly undertake the study of regional boundaries so that foundations will be prepared for planning and assisting development of rural areas from a national viewpoint, and where necessary permit the linkage of regions with common interests across State boundaries. The N.S.W. and Victorian reports and maps in the meantime are very useful for any consideration of regionalisation of agriculture by Institute Branches.

J. K. Taylor.

Research to Meet the Demands of Post-War Agriculture in Australia*

By

H. G. ANDREWARTHA,
Waite Agricultural Research Institute, South Australia.

Introduction.

In South Australia there are four separate public institutions which share the responsibility for advancing the technical efficiency of our agriculture. The Council for Scientific and Industrial Research is responsible to a Federal Minister; the Department of Agriculture and Roseworthy College are each individually responsible to the State Minister for Agriculture; the Waite Institute is responsible to the Council of the University of Adelaide, but also reports to the State Minister for Agriculture. Formal coordination of the last three institutions occurs at the political level through the Minister, and the co-ordination of these three with the Council for Scientific and Industrial Research occurs, also at the political level through the Agricultural Council. Informal co-ordination follows from the mutual goodwill and co-operation of individuals within the various institutions.

In June, 1943, the South Australian Branch of this Institute submitted a report on "Agricultural Education" to the Rural Reconstruction Commission.† This report emphasized the need for closer co-ordination between the research and extension services. One of the Commissioners, Mr. Lambert, was impressed by the low level of co-ordination which the report revealed, and he asked us to consider whether the technical efficiency of agriculture in Australia might not be advanced more rapidly if all the institutions I have mentioned were drawn into one complete organization.

Mr. Lambert's proposition involves two principles:

(*a*) The linkage between research and extension work, and
(*b*) the co-ordination of research work.

This paper is restricted to a consideration of these two principles.

The Linkage between Research and Extension Work.

All four of the institutions which I have mentioned do research work. The C.S.I.R. in 1927, in conference with the States, agreed to refrain from extension work; the Waite Institute is charged with the duty of providing an advisory service to the Minister for Agriculture in plant pathology, entomology and botany; Roseworthy College, by means of field days and by other means, makes an important contribution to the technical education of the farmer; but neither of the last two institutions maintains a staff of extension workers. Consequently, of the four institutions in South Australia which do research, the Department of Agriculture is the only one which has the advantage of an internal link between the research and extension work.

The quality of the two services, and perhaps particularly of the extension work, suffers because there is not a free enough exchange of ideas between the two services. Probably the best (if not the only) way to get a satisfactory free flow of ideas is to bring the two services under the one direction and thereby make provision for the free interchange of personnel between the two services. The other advantage of a system which facilitates the free movement of personnel between the research and

* Address given to the seventh general meeting of the Institute.

† A committee consisting of Messrs. D. B. Adam and H. G. Andrewartha, Dr. T. J. Marshall, Mr. J. K. Taylor and Professor H. C. Trumble presented this report on behalf of the Branch. In preparing this paper I have been helped by discussions with these and other colleagues.

extension services is the obvious one that it permits a worker to find the niche where he will be happy and most useful. Not everyone has the capacity to go on developing in the same restricted field all his life. At least some of the young men who enter the research services in their early twenties lack the capacity to develop into first-rate mature researchers. This may not become apparent until they have passed thirty, but by then, under the rigidity of our existing system, they may be tied to the service which they chanced to enter in their early youth. This matter was discussed by Sir David Rivett,[1] who advocated that at least part of the extension services should be recruited from the ranks of experienced research workers who had become expert in some particular field and were anxious to see the fruits of their labours incorporated into farming practice. Excellent as this suggestion is, it seems scarcely practicable while we continue with the degree of divided control which is the rule in South Australia (and Australia) at present.

The Co-ordination of Research Work.

The Department of Agriculture in South Australia originated in 1879 when Parliament decided to establish a school of agriculture and to appoint a " skilful and experienced Professor of Agriculture for the purpose of establishing more rational mode of farming ". Professor J. D. Custance arrived in 1887. The site on which Roseworthy Agricultural College was to be built later was acquired and Professor Custance set out to conduct experiments there and in other parts of the State, and he lectured to farmers. In 1912 there were, besides Roseworthy College farm, eight government farms and two government orchards. After 1912 four of these farms were closed down ; but the policy of emphasizing experimental work in all parts of the State continued. Roseworthy College has continued to be a centre for experimental work which in many ways is complementary to the work of the Department of Agriculture. Although these two institutions are responsible to the same Minister, they have become virtually independent of one another.

The other two institutions which do research in South Australia are younger. The Waite Institute and the C.S.I.R. both became active about 1926.

The enabling Act for the C.S.I.R. conferred upon it powers

(1) to initiate and carry out scientific researches in connexion with or for the promotion of primary and secondary industries in the Commonwealth ;

(2) train research workers ;

(3) make grants in aid of pure research.;

(4) establish a bureau of information for the collection and dissemination of scientific and technical matters.

It was clearly recognized by the framers of the Bill for this Act that the Commonwealth was proposing to enter a field which in a measure was already covered by existing State institutions. The Act states specifically that the Council shall as far as possible co-operate with existing organizations with a view to (*a*) avoiding unnecessary overlapping, and (*b*) utilizing facilities and staffs available in States. There can be no denying the political wisdom of these provisions. It would seem that the C.S.I.R. has done its utmost to observe these requirements ; but at times they have had a restrictive influence on the research activities of the Council.

The Waite Research Institute was established by the University Council in order to enlarge the stock of knowledge relating to agriculture in the widest sense for the benefit of those engaged in production as farmers and pastoralists. The direction in which education and research were to be pursued at the Waite Institute was further defined by Acts of the State Parliament, which provided an annual appropriation on certain conditions, viz. :

(1) Conduct research in various defined fields : cereal breeding, pasture improvement, agricultural chemistry, plant pathology, entomology, etc.

(2) Provide an advisory service to the Minister of Agriculture in botany, plant pathology and entomology.
(3) Provide a course of degree standard.
(4) Under conditions mutually agreed upon make and report to the Minister the results of any investigation in agricultural matters that he required.

The fulfilment of some of these requirements, e.g. in entomology and plant pathology, involved the appointment of experts not previously found in the State Department (but normally found in the Departments of Agriculture in other States) and hence did not create the chance of overlapping. In other fields, e.g. cereal breeding and the improvement of pastures, fulfilment of the Act obviously involved work in which the Department of Agriculture and Roseworthy College had been and still were the sole active bodies in the State.

Thus the presence of four distinct institutions in the field of research has inevitably led to overlapping of function despite efforts to prevent it. Some may consider that despite the drawbacks consequent upon inadequate co-ordination (that is to say overlapping, the restrictive influence of vested interests, and consequent inevitable separation of the direction of extension and research) the quality of research work has more to lose than it may gain from unified direction. But in this connexion it is important to discriminate between two types of research work—or rather the better distinction is between the two purposes for which research work may be undertaken.

In one case the research worker has, as his primary objective, the solving of the *ad hoc* technical problems which arise from time to time in industry. Here the course of the work is defined by the nature of the problems which are there for him who runs to read. For this sort of work the emphasis should be not so much on freedom for the individual to choose his own project but rather on freedom (and facilities) for doing the set job well. This sort of freedom is likely to be at its best inside an organization designed to promote the most efficient teamwork and to eliminate overlapping and restrictive vested interests. Consequently the divided responsibility for research work which is the rule in South Australia at present is a real disability.

But not all research work is undertaken with the primary objective of solving immediately pressing technical problems. Some of the work which has been most fruitful in the past has been undertaken because the research worker, and the community which supports him, have faith in the value of free enquiry into the " why " and " wherefore " of Nature. In this instance the problems are not necessarily well-defined for all to see ; their discovery and definition may have to await some special correlation of ideas in the mind of the researcher. Even when they have been defined it may not be easy to convince a busy executive of their worthwhileness for immediate study. Essential prerequisites for this type of work are freedom of choice and initiative for the individual worker, opportunity for unhurried thinking and discussion, and the stimulus of other minds bent on the same purposes. The universities should be able to provide these requirements.

Unfortunately the stringency of finance and the burden of teaching have imposed severe limitations upon the amount of research undertaken by the universities. For this the universities are themselves in part to blame, for, owing much of their expansion to a demand from industry for trained technicians, they have come to regard this as their major function, and not always has the clear distinction been made between the functions of a technical college and a university. Research should be restored to a more prominent place in the work of the universities for there is no substitute for the work which they can do.

This does not mean that fundamentally new knowledge may not arise from the pursuit of *ad hoc* technical problems, nor does it mean that there should be any restriction on the sort of research work undertaken by such institutions as the C.S.I.R.

and Departments of Agriculture. But it does imply that an institution which is primarily concerned with the solution of *ad hoc* technical problems and getting the results across to the farmer is different from a university and is not the best place for the prosecution of free enquiry and research into matters which, while being relevant to, are not necessarily immediately useful for, contemporary industry.

Recommendations.

In the preceding paragraphs the emphasis has been on conditions in South Australia; but most of the argument should apply to the other States. It is considered that a case has been made out for the following improvements in the organization of the agricultural research and extension services in Australia:

(1) Research and extension services should be under one direction. Co-ordination should be at the national level rather than at the State level, because:

- (*a*) Problems in agricultural research and extension do not stop at State boundaries.
- (*b*) The larger the organization the more chance for talent to find its proper level.
- (*c*) There is already a valuable and flourishing Commonwealth institution in the field of research, and the most practical step toward co-ordination would be for this institution to accept responsibility for instructing farmers in the findings of its researchers.

(2) Research and extension should be organized on a regional basis. The present structure of the C.S.I.R. with several Divisions each concentrated in a capital city would be inappropriate. This does not mean that the various Divisions might not continue to have headquarters in a suitable locality, but it does mean that the greater parts of their staffs would be housed in regional institutes distributed over the country.

(3) There is need for a big increase in the facilities for research in the universities. (This does not imply an increase in the type of services now provided by the Waite Institute which tends to be preoccupied with such " applied sciences " as cereal breeding, pasture improvement, plant pathology, etc.—as I pointed out earlier.) This might be brought about by three means:

- (*a*) A big (two or threefold) increase in the numerical strength of the teaching staff, together with a decrease in the actual burden of teaching to be brought about by a strengthening of agricultural colleges, and other technical colleges.
- (*b*) The development of active schools for post-graduate studies.
- (*c*) The universities should have the administration of a trust fund for the promotion of original research. It might be administered along the lines of the Rockefeller or Carnegie trusts for research in natural science.

An increase in teaching staff would give them more time for research; the development of post-graduate schools would provide opportunities for young researchers, and a trust fund for research would enable the universities to cater for the more mature worker of proven ability from outside the universities.

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Agricultural Climatology in Australia

By

H. C. Trumble,
Waite Agricultural Research Institute, Adelaide, South Australia.

The recent development of agro-climatological methods has led to an improved understanding of the Australian environment, and in this work special emphasis has been placed on the limitations imposed by the moisture supply of the soil.

Climatology concerns the relation of climatic factors to human requirements, and more especially those of land-settlement and production. In contradistinction to weather, which applies to the state of the atmosphere as it affects the situation at a particular time and place, climate denotes the sum total and sequence of conditions over a long period of years ; and a first essential in climatological studies is a sufficient number of appropriate meteorological records to afford a representative sample of the prevailing climate. The term agro-climatology emphasises the relationships of climatic variations to the type and effectiveness of agricultural production.

The principal climatic factors affecting the growth and distribution of living organisms are those of moisture, temperature, light and wind movement. Temperature has proved the most important of these in a world sense because it not only governs closely the rate of all biological processes, but is the most evident controlling factor for the main centres of world population and production.

World Classifications.

The principal classifications of climate date back to the period of ancient Greece when the world was divided into the well-known torrid, temperate and frigid zones. These were based only on temperature, and ignored the effects of land and sea ; moreover, the agricultural regions of importance are mainly in the temperate zone. The dual concept of temperature and moisture was introduced by Köppen,[7] whose initial method of classification was published in 1918 but has since been greatly modified. Köppen's primary belts were (*a*) tropical, (*b*) sub-tropical, (*c*) temperate, (*d*) cold, and (*e*) polar, the distinction depending on the number of months with an average temperature above 68° F. for the warmer belts and below 50° F. for the colder. These zones were again subdivided according to whether there was abundant moisture throughout the year for a longer or shorter period or not at all, and in the case of periodic rainfall, according to whether this occurred in the colder or warmer months.

A further scheme of classification was contributed by Thornthwaite[17] in 1933. It resembled Köppen's system in being quantitative and was also characterised by the use of key symbols. It introduced, however, the concept of effectiveness in regard to both temperature and rainfall ; and the variety of climatic types included was much enlarged. An informative survey of world climatic types has more recently been made by Trewartha.[19]

The above systems have been of value in comparing different regions of the earth's surface for the needs of agriculture and settlement ; but ideal measures capable of providing a basis for interpreting plant-developmental features, have not so far been attained.

Australia in Relation to Other Regions.

The agricultural experiences and plant material available in the older settled regions of the world render it desirable that the relationships of the main types of climate in Australia to those of other countries should be clearly understood. The use of homoclimes requires to be adopted with some caution as it is unlikely that

climates of widely separated regions can be in every way identical ; and the climatic complex contains so many variables that a critical determinant of plant survival may be easily missed.

Sufficient information is available to indicate, however, that in a generalised way the desert and steppe regions of central Australia find their climatic counterparts in North Africa, South Africa, Western Asia and the south-western portion of North America, with a small area also in South America. Northern Australia is distinct from New Guinea and the East Indies ; its conditions of climate are more comparable with those of East Africa, India, Indo-China and that portion of Brazil to the south of the Amazon basin.

The three major temperate or near temperate types of climate in Australia are those of (*a*) south-eastern Queensland and north-eastern New South Wales, (*b*) south-eastern New South Wales, southern and eastern Victoria and Tasmania, and (*c*) the agricultural areas of South Australia and Western Australia. The summer rainfall type which characterises (*a*) has its nearest counterparts in the Argentine and southern Brazil, the south-eastern United States, south-eastern China, Japan and the Natal province of South Africa. The marine temperate type covered by (*b*) is also that of New Zealand and western Europe, including southern Scandinavia, the Netherlands, western Germany, most of France and the whole of the British Isles. This type also occurs in Oregon, Washington State and the Vancouver region of western Canada. The agricultural areas of South Australia and Western Australia, under (*c*), have the climate of the Mediterranean, which is also found in the Cape Colony of South Africa, California and Chile.

Extensive areas of Canada, the north-eastern United States, central Europe and Russia are characterised by a colder and more continental type of climate, not found in any part of Australia or New Zealand ; and requisite care should be taken therefore in the application to Australian problems of methods developed in those countries.

The humid-temperate and sub-tropical areas are among the most important agricultural regions of the world. Under arid and semi-arid conditions, however, human occupation has invariably led to the intensification of desert conditions.

Climatic Indices Developed in Australia.

The Australian climatic environment was studied comprehensively by Griffith Taylor,[16] whose work provided a descriptive basis for the quantitative measures of more recent years. A review of Australian climatological and meteorological work to about the outbreak of war in 1939 was made by Lawrence.[9]

The limiting factors of greatest importance in Australia have been those relating to the moisture supply and its variability over the years. Available moisture depends on the rate of gain by precipitation and the rate of loss by soil evaporation and/or transpiration. The ratio of rainfall to evaporation is thus of special value as a single index to rainfall effectiveness and has tended to become a standard measure in recent years.

Prescott,[10, 11] first employed this type of ratio in Australia, but the Meyer ratio of rainfall to saturation deficiency was chosen rather than the Transeau ratio of rainfall to evaporation. The relationship between saturation deficiency and evaporation has rendered it possible to express measures of temperature and humidity, where these are concurrently available, in terms of free water evaporation from a standard tank. From the saturation deficiency values, Davidson[3, 4, 5, 6] was able to determine the mean monthly evaporation rates for Australian stations and the ratios $R/E=1{\cdot}0$ and $R/E=0{\cdot}5$ were employed as critical values limiting insect development. The lower of these, in conjunction with the mean annual temperature, was taken as a basis for the construction of bioclimatic zones.

The seasonal relationship between length of day, temperature, rainfall and evaporation has been shown[20] to govern the type of agriculture practised in southern Australia, and the critical limiting value of the R/E ratio under average seasonal

conditions at Adelaide was found from investigation to be approximately 0·3. This factor was utilised to determine the mean period of influential rainfall; and agro-climatic zones were established for southern Australia[21] on a basis of the mean length of the rainfall season and the mean monthly temperatures for the three coldest months.

Evaporation from Water and from Soil.

Later work by Prescott[12] has emphasised the significance of solar radiation in governing the rate of evaporation under conditions of high saturation deficiency; and attention was drawn to the lag between the various meteorological elements controlling evaporation on the one hand and solar radiation on the other.[13, 14] This introduced the concept of phase, which depends on both latitude and distance from the ocean. The use of phase in conjunction with temperature provides a further method of assessing evaporation, but seasonal values for saturation deficiency have shown a close relationship with actual evaporation at both Adelaide and Pallamana, in the South Australian mallee; and their use has been justified by the conformity of the resulting measures with field observation.

The wider installation of standard evaporimeters, provided these are maintained as scientific instruments, is likely to be of considerable value. Thornthwaite[18] stresses the limiting conditions of the various empirical formulæ employed to assess evaporation, and has indicated that there is no really effective substitute for the direct measure of evaporation and transpiration in computing the losses of moisture from soil.

The adoption of the ratio $R/E = 1/3$ was based on comparative studies of evaporation trends from soil blocks and free water surfaces.[20] The value has been confirmed for South Australian conditions within the range of 3-6 inches free water evaporation per month from a standard tank; evaporation of this order occurs in late March, April, May, September, October and early November over most of the agricultural areas. With lower evaporation rates, a ratio closer to 0·5 would be justified; such a factor also serves for these months where supplies of soil moisture well above the critical wilting point value need to be constantly maintained, as in the case of transplanted guayule seedlings.[2]

At high rates of evaporation and with xerophilous species a lower factor is more appropriate. A ratio of 0·20 or 0·25 was earlier suggested for Queensland,[21] and observation in the field has indicated a value more nearly approaching 0·1 for conditions north-west of Pt. Augusta, where evaporation rates of 8-14 inches per month are frequent in summer. The highest amounts of monthly evaporation recorded in Australia are of the order of 12-14 inches per month (e.g. Yudnapinna, Marble Bar, Coolgardie). Over the range of 1-14 inches evaporation per month the factor applicable might thus vary from 0·5 to 0·1.

Duration of Periods Relating to Growth.

Direct graphical measurement of the length of the period of influential rainfall was avoided,[20] as this did not result in conformity with the field position regarding moisture. The standard method employed has been to include the whole of each month in which R exceeds E/3 and in addition fractions of the months at the ends of the periods in proportion to the steepness of the cross-over of the values R and E/3. This procedure was adopted on consideration of the observed behaviour of pastures at the Waite Institute in comparison with the changing seasonal relationship between rainfall and evaporation over a period of ten years.

The value of R/E for a single month or preferably for shorter periods can be regarded as a basic agro-climatic measure under Australian conditions. Yearly values are of little value; and the sequential variation in the moisture factor expressed in terms of the R/E ratio taken in conjunction with the march of temperature and

length of day in an individual season enables the plants' responses to changing climatic factors to be interpreted. The incidence of varying types of combinations over a sufficient period of years provides the key to ecological adaptability and the degree of agricultural production attainable.

The need for joint consideration of rainfall and evaporation was emphasised in the Third Report of the Rural Reconstruction Commission,[15] and a simplified map appearing as Figure 1 in this Report gives a clear picture of the areas in Australia with an average growing period of less than five months, which are purely pastoral or desert, those with five to nine months where seasonal agriculture may be practised and the relatively limited area with an average growing period of more than nine months, where dairying and other intensive forms of production are possible.

Variability.

Much of the work on climatic variability, as for instance that reviewed by Lawrence,[9] has dealt with the frequency of meteorological events without relation to agricultural problems; her own earlier work,[8] however, emphasised the dependence of land use and crop production in New South Wales on the frequency of critical climatic phenomena within specified periods of time. The influence of rainfall variability on production is emphasised in the Rural Reconstruction Commission's Report.[15]

The variability of the length of the rainfall season and the amounts of influential rainfall in South Australia were determined by Wark,[24] who assessed the probabilities with which rainfall seasons of varying lengths and varying amounts of influential rainfall could be expected to occur. From the resulting data, the expectancy of favourable conditions of moisture occurring at any time and for any period of the year can be determined. A further step at Adelaide has been the relation of the expected occurrence of effective rainfall periods of four and five months to fat-lamb production in this State.[22] The determinations of the frequencies depended on the recorded occurrence of such periods at 20 stations and a high degree of relationship of these values to the mean length of the rainfall period at the same centres. As the latter value had been determined previously for more than 200 stations, it was possible to calculate expectancies for the entire range of centres.

A similar type of approach has been followed by Blumenstock,[1] who has assessed the probability of drought occurrence in the United States based on records over the interval 1898-1937. Drought was arbitrarily defined in terms of an absence of 0·10 inch or more of rainfall in 48 hours or less, and the frequency of drought periods of varying lengths determined.

Relationship of Climatic Indices to Land Use and Production.

The main functions of average values are to determine specific zones which can be related in part to generalised soil types, to the natural vegetation and to the form of agricultural development and production.

In South Australia recommendations relating to the war-time production of flax, the location of post-war settlement, the possibilities of growing new crops and the future expansion of livestock production have been based on the greater use of natural climatic resources, which increase with (*a*) expansion of the period of influential rainfall, and (*b*) decreasing probability of the occurrence of critical drought periods. These two conditions tend to be linked.

The main pitfalls to be avoided in using agro-climatological measures lie in (*a*) the exclusive employment of means, yearly values, abstract expressions generally, and (*b*) the treatment of climatic data without experience and understanding of the biological phenomena which climatic data has been utilised in part to interpret.

It follows that the unit of climatic measurement needs in the last resort to be that of the individual season or a portion only of the season, and that records of

production need to be studied in conjunction with such measures. Evaluation of relationship and dependence is secured by analysis for regression, which has been employed to investigate the effect of total rainfall or rainfall at a particular time on plant production. The method was applied to the yield of pasture at the Waite Institute by Trumble and Cornish[23] and examples have also been given[15] of work carried out by Cornish, Phipps and Pugsley, in which the effect of rainfall at different times of the year on the yield of wheat in South Australia has been determined. The type of approach may be closely allied to investigations of trends in soil fertility, in which variations due to climate are isolated from those due to other causes; the amount of statistical detail and control involved renders this especially informative.

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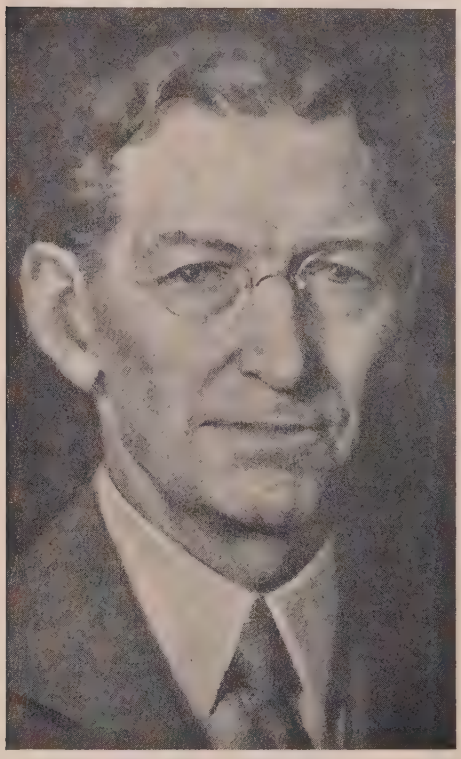
Lewis Ralph Jones, 1864-1945

Few men have had greater influence on the development of the philosophy of modern plant pathology than Professor L. R. Jones, and probably no teacher has trained more plant pathologists.



L. R. JONES.

Lewis Ralph Jones took up the study of diseases of plants at a period when the science of mycology was becoming differentiated from general botany and was proceeding to show itself immediately useful in contributing to human endeavour and happiness. The science of phytopathology was entering the Millardetan or economic period and L. R. Jones contributed heavily in giving the infant science its correct orientation. He quickly won prominence for his investigations of the etiology and control of the potato blights and the soft rot of vegetables. These studies were commenced in 1890 when he was botanist to the Vermont Experiment Station and, involving much field work, doubtless influenced greatly the formulation of the doctrine of the tri-factorial cause of plant disease he later taught his students. Historians will always link the name of L. R. Jones with that of H. Marshall Ward in this connexion, and it is of interest that it was a field investigation of the coffee disease in Ceylon by Marshall Ward in 1881 that changed him too from a mycologist to a plant pathologist.

L. R. Jones was born on a farm in Wisconsin but took his first degree at the University of Michigan. In 1889 he accepted the post of botanist at the University of Vermont and became renowned as a teacher, as well as an investigator. In 1909 he was invited to found the Department of Plant Pathology at the University of Wisconsin and in the same year was prominent in the foundation of the American Phytopathological Society and became the first President. At the beginning of its third year the Society undertook the publication of a journal—*Phytopathology*—and L. R. Jones was its first editor. His reputation as a teacher continued to attract students to his laboratories at Wisconsin. He won additional fame by his development of a method of control of Cabbage Yellows, a disease caused by a soil-invading fungus, by the field selection of disease-resistant plants, then a relatively new method of approach to a soil problem. Under his guidance and inspiration teams of keen young graduate students applied themselves to the study of environment in relation to host and pathogen in developing the control of many important diseases, and from Wisconsin carried back to their States, or country, Jones' viewpoints and methods. The Wisconsin soil temperature tanks will always be an instrument in plant disease investigation.

Professor L. R. Jones was a kindly man of high ideals who inspired confidence in his students and the will to learn. He was blessed with the humility found in the truly great. He was not skilled at exposition in the traditional way but sought rather to guide the thoughts of his students along the paths his own had followed in probing the unknown. He maintained close personal contact with his students and in a friendly manner asked them many apparently simple questions. All his students will recall his oft-repeated phrase at the termination of many a conversation that such and such an unexplained point " is a challenge ". L. R. Jones possessed an analytical and critical mind, rare judgment and keen appreciation of the farmer's viewpoint. The plant was always the central theme in his attempts to evolve a control practice.

Professor Jones was a member of numerous scientific societies at home and abroad. He was a member of the U.S. Science Advisory Board, President of the Tropical Plant Research Foundation, and a trustee of the Boyce-Thompson Institute for Plant Research. A signal tribute was paid to him on the occasion of the International Congress of Plant Sciences at Ithaca, N.Y., in 1926 when several hundreds of his former students from almost every State and many foreign countries gathered at a banquet in his honour. He was the recipient of honorary degrees from several American universities and the honorary degree of Doctor of Science was conferred on him by the University of Cambridge. He retired from the University of Wisconsin in 1937 but led an active life in scientific advisory and committee work until his death at Orlando, Florida, on 1st April of this year.

C. J. Magee.

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Host Specificity Amongst Root-Nodule Bacteria Isolated from Several Clover Species

By

J. M. Vincent, B.Sc.Agr., Dip.Bact. (Lond.),
School of Agriculture, University of Sydney.

It is well known that the specific relation between invading organism and the host plant is one of the major factors that determine the degree of nitrogen fixation achieved by the association of root-nodule bacteria and legumes. Fred, Baldwin and McCoy[4] summarise the earlier findings, and Wilson[14] the more recent work in this connexion.

The most important results reported for the clover organisms are those of Strong[11] who, working with South Australian strains as well as several " collection " cultures, revealed what appeared to be a striking relationship between the species of host from which the strain was originally isolated (field host) and its subsequent behaviour when tested with subterranean clover (*Trifolium subterraneum*), white clover (*T. repens*) and red clover (*T. pratense*). Strong's eight strains for which field hosts were recorded fell into two contrasting groups : (*a*) four strains isolated from subterranean clover which were effective with subterranean clover, but ineffective with both red clover and white clover ; (*b*) two strains from each of white clover and red clover which were effective with either red or white clover, but ineffective with subterranean clover. Consequently it was recommended that separate cultures should be issued for subterranean, as distinct from other clover species such as red and white clovers.

However, results obtained independently by Jensen and the author,[7] with strains obtained from widely separated locations and from more field hosts than those

reported by Strong indicated that the relationship was not as clear as might have been expected from the latter's findings.

The present paper summarises the results which have now been obtained with isolates from several species of *Trifolium* when tested against ball clover (*Trifolium glomeratum*) in addition to the species used by Strong.

Experimental.

The methods used for the isolation and testing of cultures for nitrogen fixation are essentially those in general use for studies of this nature.

Source of Cultures.

Twenty strains have been tested. Most have been isolated from clovers collected in New South Wales, Victoria, South Australia or the Australian Capital Territory. A few stock cultures have been included for one of which the original host species was known. Details for 18 strains are given in Table 2; strains 61 (from woolly clover, *Trifolium tomentosum*, Euston, N.S.W.), and 91 (from ball clover, Narrandera, N.S.W.), have been omitted from this report because of their variable nitrogen-fixing behaviour as already noted.[13]

Assessment of Effectiveness.

At least one test (usually more) has been made by growing test plants in nitrogen-poor sand in open pots and determining dry weights and total nitrogen. These results have been subjected to appropriate statistical analysis. In addition plants have been grown in large tubes on nitrogen-poor agar medium, growth being assessed by eye.

Close agreement has been found between objective visual estimates made during the course of growth and the final detailed analysis. It has also been observed with both clovers and medics that the cotyledons give a good indication of the relative effectiveness of an association. The cotyledons of control plants became yellow and shrivelled well in advance of those effectively associated plants. Partially effective associations were intermediate in time and degree of yellowing, whilst ineffective associations were scarcely better than the controls. Data for subterranean clover, recorded in Table 1, are an example of the results that have been regularly obtained.

TABLE 1.

Growth Characteristics of Subterranean Clover in Relation to Effectiveness of Association with Rhizobium Strains.

Treatment.	Visual Estimate.	Greenness of Cotyledons.	Total N per Plant. Mg.	Final Grading.
Control	28	0	0·55	
Strain 36	100	10	3·59	Effective.
,, 108	83	10	2·50	Effective.
,, 142	56	3	1·55	Partially effective.
,, 160	33	1	0·64	Ineffective.

For the purposes of this paper the association is recorded as *E* (effective) where there is a marked increase in growth over the control, as *P* (partially effective) where growth is undoubtedly better than the control but much inferior to the cases reported as effective, as *I* (ineffective) where the inoculated host is little, if any, better than the control.

Results.

Results of tests with 18 strains on four host species are set out in Table 2, in which data obtained from many experiments are summarised for each host-organism association. Strains have been grouped into what might be regarded as similar host patterns. Such a grouping is valid, of course, only in respect of the four host species at present utilised.

These results emphasise the importance of the host plant used for the test, as well as the bacterial strain, in determining effectiveness, and point to the complexity of the relationship. No organism was wholly ineffective with all four species; on

the other hand only two (165 and 200) were effective with the four hosts. In the case of strain 165, the amount of nitrogen fixed was high only for the host from which it

TABLE 2.

Summary of Organism-Host Relationship between Rhizobium trifolii *and* Trifolium *spp.*

Strain No.	Initial Host.(*a*)	Locality.	Effectiveness (*b*) with				Antigenic Constitution. (*c*)	
			T.S.	T.G.	T.R.	T.P.	Flagellar.	Somatic.
165	T.P.	Glen Innes, N.S.W.	E	(E)	E	E	—	—
200(*d*)		Waite, RT3, Wisconsin	E	(E)	E	E	—	—
108	T.S.	Manildra, N.S.W. ..	E	E	E	P	A	I
36	T.R.	Manildra, N.S.W. ..	E	E	E	P	A	I
46	T.S.	Dandenong, Vic. ..	E	E	E	P	B	III
94	T.F.	Penola, S.A. ..	E	E	E	P	A	II
86	T.G.	Temora, N.S.W. ..	E	E	E	I	A	—
111	T.R.	Manildra, N.S.W. ..	E	P	E	I	A	II
20(*d*)		Dept. Agric., W.A.	E	P	P	P		
201(*d*)	T.S.	Waite, RT13, S.A. ..	E	P	P	I	A	II
142	T.G.	Goonoo Goonoo, N.S.W.	P	E	E	I	—	—
39	T.S.	Duntroon, A.C.T. ..	P	P	(E)	P	—	—
64	T.R.	Orbost, Vic.	P	I	E	P	B	I
157	T.R.	Glen Innes, N.S.W.	I	I	E	E	—	—
156	T.G.	,, ,, ,, ..	I	I	E	E	A	—
164	T.P.	,, ,, ,, ..	I	I	E	E	A	—
160	T.P.	,, ,, ,, ..	I	I	E	P	A	—
161	T.P.	,, ,, ,, ..	I	I	E	P	—	—

(*a*) T.F.=*Trifolium fragiferum*. T.G.=*T. glomeratum*. T.P.=*T. pratense*. T.R.=*T. repens*. T.S.=*T. subterraneum*.
(*b*) E=effective. P=partially effective. I=ineffective. ( )=tentative.
(*c*) Symbols for antigenic constitution are those adopted in an earlier report.[12]
(*d*) Stock cultures obtained from the outside sources indicated.

came, viz. red clover. With the other hosts the amount of nitrogen fixed was towards the lower end of the range graded as effective. Strain 200 fixed less nitrogen with ball clover than with the other three species.

Comparison of Testing Hosts.

The distribution of gradings for the 18 strains with each testing host is given in Table 3.

TABLE 3.

Distribution of Effectiveness Gradings in Relation to Testing Host.

Testing Host.	Nature of Association.		
	Effective.	Partially Effective.	Ineffective.
Subterranean clover ..	10	3	5
Ball clover	8	4	6
White clover	16	2	0
Red clover	5	9	4

This distribution differs significantly ($P<0.01$) from what would be expected if each testing host showed the same proportion of effective, partially effective, and ineffective associations. The principal departures from such an expectancy are in the greater number of effective and smaller number of ineffective associations found with white clover, and in the high number of partially effective associations found with red clover. So far as these 18 strains are concerned, it might then be concluded that white clover is more compatible than either subterranean or ball clover, and that red clover is intermediate in its compatibility. Reference to Table 2 shows that the behaviour of strains with subterranean clover is largely paralleled by their behaviour towards ball clover. This positive association was highly significant ($P<0.01$).

Effectiveness of Association in Relation to Testing Species and Initial Field Species.

In Table 2 effectiveness ratings are available for 64 associations in which the species of the field host is known. Fifteen of these were tests with the same host species as the field host, and 49 were with species different from the field host. The effectiveness of associations in relation to these two groups is set out in Table 4.

TABLE 4.

Comparison of Effectiveness when Tested with Species the Same as, or Different from, the Field Host.

Testing Host.	Nature of Association.			Total Observed.
	Effective. Obs. Exp.*	Partially Effective. Obs. Exp.*	Ineffective. Obs. Exp.*	
Same species as field host	11 (8·0)	3 (3·5)	1 (3·5)	15
Different species	23 (26·0)	12 (11·5)	14 (11·5)	49
Totals	34	15	15	64

* Values listed as expected (exp.) represent in each case the column total × horizontal total divided by the grand total (64).

The pattern of effectiveness when the testing species is the same as the field host is not significantly different from that in which the testing species differs from the field host.

In view of the parallelism in behaviour between subterranean and ball clovers, the data were examined further in Table 5.

TABLE 5.

Effectiveness of Associations Grouped According to Field and Testing Hosts.

Isolated from.	Tested Against.	Nature of Association.		
		Effective.	Partially Effective.	Ineffective.
Subterranean or ball clover	Subterranean or ball clover	8	4	2
,, ,, ,, ,,	Red or white clover ..	7	4	3
Red or white clover ..	Subterranean or ball clover	5	2	9
,, ,, ,, ,, ..	Red or white clover ..	11	4	1

Isolations from subterranean or ball clover obviously do not differ when tested against their own group or against red or white clover treated as a group. The distribution in the case of the isolates from red or white clovers is, however, significantly different according to whether the testing host was subterranean/ball clover or red/white clover (P=0·01). The common origin of the red clover strains (all from the same farm) needs to be kept in mind in interpreting this result.

Behaviour of Strains according to Initial Location.

The data offer some opportunity for comparison of strains coming from the same area. Of the three strains from Manildra, two (108 and 36) are known to be serologically identical[12] and, although coming from different host species, show a very similar pattern of behaviour with the four test species. Strain 111, which has the same flagellar antigens but differs in its somatic constitution, differs also in its effectiveness pattern. Five of the six Glen Innes strains show very similar behaviour even though they come from three different host species and represent at least two serological groupings. The remaining strain (165) provides quite a different pattern of effectiveness.

Behaviour of Strains in Relation to Serological Constitution.

Experience with substrains of 61 and 91, which varied in effectiveness despite the same antigenic constitution,[13] and an examination of the data reported above would not lead one to expect much, if any, relationship between these characteristics. The only cases which show anything like a similar pattern of host relationships together with the same antigenic constitution (108, 36 and 156, 164, 160) come from the same areas, which might provide an explanation for the agreement in behaviour. Consideration of flagellar and somatic antigens separately does not reveal any obvious relationship to effectiveness grouping.

Discussion.

Amongst the factors which have been examined in attempts to find a cause for the specific relationship between an invading organism and the species of testing host, some attention has naturally been given to the field host from which the strain was primarily isolated. Nobbe, Hiltner and Schmid (quoted by Allen and Baldwin[1]) noted that a culture from vetch gave large and effective nodules on vetch plants but small and less effective nodules on the roots of peas (*Pisum sativum*). Helz, Baldwin and Fred[5] state that their strain 13, isolated from *Vicia faba*, gave excellent plant growth when used with this host in comparison with strain 20 from peas. These workers stated, too, that the relationship was reversed when the two cultures were used to inoculate peas. Examination of their data, however, shows that the results are not as striking as might be expected. Results given in three experiments with peas and two with species of *Vicia* are abstracted in Table 6.

TABLE 6.

Results with Several Testing Hosts Abstracted from Data of Helz et al.[5]
(Average air-dry weight per plant in grams.)

	Peas.	Peas.	Peas.	*Vicia faba.*	*Vicia villosa.*
Strain 13 (from *V. faba*)	0·777	0·606	0·922	0·077	0·395
Strain 20 (from peas)	0·955	0·553	0·920	0·066	0·343
Control	0·314	0·539	0·729	0·049	0·163

Working with members of the same inoculation group, Erdman and Burton[3] found that a strain from hairy vetch (*Vicia villosa*) proved one of the best with all varieties of peas under test.

With clover organisms it is interesting to record that strain 202 used by Löhnis[10] was originally isolated from red clover and that this host was amongst the species for which the strain was ineffective. Strong's findings[11] with eight strains isolated from three hosts and tested against the same three species suggested a clear relationship between initial host and the effectiveness of an association. The results reported in this paper, taken as a whole, suggest that there is no better relationship between initial host and performance than might well be obtained by chance. Considering subterranean/ball clovers as a group and red/white clovers as another, there is some likelihood that the strains coming from red clover tend to be ineffective with subterranean or ball clover. Against this the particular location of the red clover isolates needs to be kept in mind. Kleczkowska *et al.*,[8] reporting cases of cross infection between some members isolated from clover and some isolated from peas, noted that such cases were definite, though limited and delayed. In no case did the host plant (pea with clover isolate, clover with pea isolate) derive benefit from the strain belonging to the other inoculation group.

The findings of Burton and Erdman,[2] who worked with a large number of isolates from recorded hosts are also of interest. Isolates from *Medicago sativa*, *Melilotus alba* and *Mel. officinalis* failed to cause appreciable nitrogen fixation with the burr clovers (*Medicago hispida*, *M. arabica* and *M. lupulina*), although they were in most cases effective with their own host species. Burr clover and *Trigonella foenum-Graecum* isolates, on the other hand, showed as satisfactory performance with lucerne and the sweet clovers as with their own hosts. The one strain reported from *Mel. indica* was effective with burr clover and *Trigonella* as well as with lucerne. Burton and Erdman favour an explanation which would involve strains associated with lucerne and sweet clover having lost, as a result of that association, some factor required with the burr clover/*Trigonella* group. No real evidence is offered to support this interpretation to the exclusion of other possibilities which would seem just as likely, as well as equally difficult to prove or disprove. The plant passage experiments of Allen and Baldwin[1] are probably most relevant to any suggestion that the host, by modifying the strain, alters its subsequent nitrogen-fixing ability in a particular association. Even in this case it is not certain that it is not more a matter of selection than an impressed variation. Furthermore the rise and fall in effectiveness is not readily adapted to Burton and Erdman's postulate. A second possibility mentioned by Burton and Erdman, but not favoured by them, seems just as valid. This would suggest that plants of the burr clover/*Trigonella* group might be more exacting, or more specific, in their requirements. It might be expected, then, that isolations that have qualified for successful association with this group (and isolations from such plants might well represent a selected sample) would at the same time be able to work with a less specific association. Again on the basis of what we know about adaptive and constitutive enzymes, it would be easy to suggest that burr clover and *Trigonella* isolates might have become adapted either by selection or by the development of a new factor as a result of association with the appropriate host.

The explanation of some of the present discrepancies might rest in the observation made by Helz *et al.*[5] : " When an organism is isolated from a host plant, it is usually impossible to determine its previous history, and it is possible that a strain isolated from a pea nodule may have been associated with vetch or some other host of the cross inoculation group within a few previous generations." Certainly there remains much room for experimentation including more thorough investigations and the influence of what might be called " field factors " on subsequent effectiveness with particular hosts. More work needs to be done with isolates of known host history and coming from carefully recorded locations. Cases of this latter type have already been examined using serological behaviour as a basis for differentiation.[6] It was found that even amongst strains obtained from close proximity there could be considerable serological heterogeneity. Similar studies using effectiveness pattern with a range of hosts might also profitably be undertaken. It would be interesting

to determine whether, using this criterion, there would be as great diversity as that recorded for antigenic constitution. The few cases it has been possible to consider in this paper might suggest the possibility of a greater uniformity.

Such data as there are for comparing effectiveness with antigenic behaviour agree substantially with those reported by Kleczkowski and Thornton,[9] except that no support is offered for the partial correlation found by these authors between flagellar antigens and effectiveness. Indeed, it would be hard to see how such a correlation, established for tests with one host, could stand up to an examination for effectiveness against a range of hosts. Information given by Kleczkowski and Thornton does not throw any light on whether there is some other factor such as location common to many of these strains, which might have resulted in a parallelism between serological behaviour and the level of effectiveness against red clover, without there being any causality between the two conditions.

Summary.

Results are reported for 18 strains of root nodule bacteria isolated for the most part from several clover species growing in recorded locations, and tested for their ability to fix nitrogen in association with four species of host plants. In most cases some information is available respecting the serological constitution of the strains.

The data emphasise the importance and complexity of the organism-host relationship. Eighteen strains set out against the four hosts provide no less than seven, and possibly more, patterns of effectiveness. The four test hosts may be regarded as differing in their compatibility, at least in respect of these 18 strains; subterranean and ball clovers showed a significant agreement in their behaviour to the same strains. The results fail to substantiate the striking field to testing host relationship reported by Strong, except in respect of isolations from red clover tested with subterranean or ball clover. There is no relationship between effectiveness patterns and what is known of serological behaviour, but some likelihood that strains coming from the same area might show a degree of common behaviour in their host relationships.

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Present and Future Trends of Tomato Varieties in Australia

By

E. M. Hutton,
Division of Plant Industry, Council for Scientific and Industrial Research, Canberra, A.C.T.

War has given a particular stimulus to the growing and processing of vegetables so that in the last few years more emphasis than ever before has been placed on varietal problems in vegetable crops throughout Australia. Due to its high vitamin C content, and its value both fresh and processed, considerable attention has been devoted to tomato varieties. Many of the well-known varieties, much advertised in seedsmen's catalogues prior to the war, have been rapidly displaced from commercial plantings in a few years by comparatively new varieties. A notable achievement in this direction has been the development of the Tatura Dwarf Globe tomato by the Victorian Department of Agriculture. Over the last three years, the acreage planted to this variety has continually increased so that it now plays a very significant part in what can be described as the two largest tomato growing areas in the Commonwealth, viz. the irrigated Goulburn Valley of Victoria, and the Murrumbidgee Irrigation Area in New South Wales.

A General Agronomic Comparison between some Old and More Recent Tomato Varieties.

Over the last three years, approximately 60 distinct tomato varieties from Australian and overseas sources have been subjected to a critical study under unstaked conditions in tomato areas throughout Australia, with a view to ascertaining the agronomic characters required in modern varieties. In order to make comparisons between varieties, and at the same time give an overall picture of their performance in various districts, a simple and arbitrary pointing system was adopted. In this system the agronomic characters considered most important and the points allotted to each character are as follows: yielding ability 10, external fruit characters 5, internal fruit characters 5, and bush type 5. On this basis, an analysis of 27 representative varieties is shown in Table 1. It will be noticed that varieties have been judged under unstaked and untrained conditions. This has been to the disadvantage of such varieties as Bonny Best, Rutgers, Earliana, Potentate and Marglobe, all of which are staking types. However, large-scale commercial production of tomatoes in Australia during the war has been developed without staking and training, and the practice is likely to continue for such conditions after the war. In the United States of America the acreages of unstaked tomatoes far exceed those that are staked, and most modern varieties from this country have been developed for untrained conditions.

In Table 1 those varieties receiving 19 points or more are considered the most dependable all-round varieties for Australian conditions, with the reservation that the late and even the mid-season ones would not be of use where a short season is experienced, as in Tasmania. It will be noticed that Bonny Best, which has been a standard variety for so long, occupies an intermediate position on this list with 18 points. Those varieties receiving 17 points or less are regarded as unsuitable generally, although it is admitted that varieties like Adelaide Dwarf Red, Rutgers and Potentate are very successful under certain conditions.

It will be seen in Table 1 that the emphasis has been placed on good yielding varieties which have a firm, smooth, globular fruit. Processors favour this type of fruit, and although buyers on the pre-war fresh market were not particularly

TABLE 1.

Agronomic Analysis of Some Tomato Varieties Grown under Unstaked Conditions.

Variety.	Maturity.	Yielding Ability. Points 0–10	External Fruit Characters. Points 0–5	Internal Fruit Characters when Cut. Points 0–5	Bush Type. Points 0–5	Total. Points 0–25
1. Pearson	L	10	4	4	5	23
2. Red Cloud* ..	E	10	4	5	4	23
3. Grosse Lisse ..	M	7	5	5	4	21
4. Tatura Dwarf Globe	E	9	5	2	4	20
5. Riverside	L	8	5	4	3	20
6. Sioux*	E	7	4	5	4	20
7. Break o' Day ..	M	7	5	5	2	19
8. Bounty	E	8	4	4	3	19
9. Indiana Baltimore	M	6	4	5	4	19
10. Pritchard	L	7	5	4	3	19
11. Stokesdale ..	M	7	5	4	3	19
12. Bonny Best ..	M	7	5	3	3	18
13. Adelaide Dwarf Red	E	9	1	3	4	17
14. Earliana	E	6	5	4	2	17
15. Rutgers	L	6	4	3	4	17
16. Burwood Prize ..	L	5	5	4	3	17
17. Pan America ..	L	5	4	4	4	17
18. Potentate ..	M	9	4	1	2	16
19. Rouge de Marmande	E	8	2	3	3	16
20. Improved Stone ..	L	4	5	4	3	16
21. Marglobe	L	5	4	4	3	16
22. Vetomold ..	M	7	3	1	3	14
23. Washstate* ..	M	5	5	1	3	14
24. Early Chatham ..	E	5	3	3	2	13
25. Bison*	M	3	3	3	3	12
26. Livingstone Globe	L	4	3	3	2	12
27. Ponderosa ..	L	3	3	3	2	11

* Recent varieties which have not had extensive trial.

discriminating, it is considered that the future consumer demand will be more and more directed towards a well-flavoured, smooth, firm fruit. In addition, the producer is beginning to realize that many of the newer types carry better, and can be picked earlier than the old types. A variety like Pearson, if cut a week before colouring, will be found to have reached the reddish-pink stage internally, and thus be at an ideal stage for transport. These remarks apply particularly to the fresh market, since the stage of maturity when picking for the cannery is later than this, and tomatoes used for the latter purpose should not be transported any great distance.

Table 1 is also of interest in that it helps to emphasize the strong and weak points, agronomically, of the better known varieties when considered in relation to present and future commercial requirements. The table indicates, further, that with very little effort a plant breeder could in a few years synthesize some first-class agronomic types out of available material. Pearson has outstanding bush and yielding characters, but is late maturing and has a tendenty to produce fruit with a white core. Tatura Dwarf Globe is a very good type, but its internal fruit characters need improving before it could be classed good all round. Bounty does extremely well under cool conditions, but has an objectionable blossom end scar and rather poor leaf coverage.

Maturity in Tomato Varieties.

Whatever the district, early maturity is a distinct asset in any variety, provided it is accompanied by other desirable agronomic characters. It is considered that early maturity should be one of the main aims of the tomato breeder, since there is a distinct dearth of really good early varieties available. In the Murrumbidgee Irrigation Area, one of the main reasons for the success of Tatura Dwarf Globe tomato against Pearson is the earliness of the former. It is often considered that differences in time of maturity between early and late varieties are practically ruled out under hot irrigated conditions. In experiments in the Northern Territory and at Merbein in Victoria, varieties like Adelaide Dwarf Red and Pennheart have matured two to four weeks earlier than Pan America and Pearson. When early varieties yield as well as, and often better than, late ones under these conditions, it is obvious that late varieties are not an economic proposition by comparison.

At the other extreme, in cool climates with a short season, as in Tasmania, early maturity is an essential in order to produce a payable return of ripe tomatoes out of doors. As a result, varieties like Bounty, Rouge de Marmande and Burwood Wonder are used for such conditions.

The factors determining early maturity in tomato varieties are not definitely known. It is suggested that earliness is often due to the ability to set fruits under the cooler conditions early in the season, since it is common to see early and late varieties flowering at the same time.

Yielding Ability in Tomato Varieties.

This tends to be the most variable character in tomato varieties, since the percentage of flowers setting fruit in any particular variety varies widely under different conditions of temperature and humidity. Varieties like Adelaide Dwarf Red and Tatura Dwarf Globe set and yield well under both hot and cool conditions. On the other hand, Bounty, Rouge de Marmande and Burwood Wonder set their best yields under relatively cool conditions, and are at a disadvantage under hot conditions. Pearson, Rutgers, Burwood Prize, Riverside, Break o' Day and Pritchard set and yield best under hot conditions. As a result, Pearson, Tatura Dwarf Globe and Adelaide Dwarf Red are commonly seen side by side under hot irrigated conditions in the Murray valley, and at Leeton and Griffith, New South Wales. In Tasmania, Rouge de Marmande and Bounty are particularly favoured, while in the Northern Territory, Pearson, Rutgers and Pritchard have been found very reliable varieties.

Another point which needs to be considered in relation to the yielding ability of a variety is the length of time over which it will produce economic yields. Varieties like Pearson tend to produce heavy yields over a relatively short period, whereas a variety like Adelaide Dwarf Red yields heavily over a much longer period. This is an important consideration in areas with a long growing season, since it could mean two plantings during the production period instead of three.

External and Internal Fruit Characters of Tomato Varieties.

Most will agree that externally the fruit of a tomato variety should be smooth and globular and possess an attractive, bright red colour. A number of modern varieties produce this type of fruit, but there are many in which the fruit is often marred by stylar end scars and cracking of a circumferential or radial nature. The stylar end scar seems to be a heritable character in varieties like Bounty, so would be eliminated most easily by breeding. The extent of cracking is influenced greatly by environmental conditions, but there is a tendency for varieties such as Rutgers, Marglobe and Pan America to crack radially irrespective of the districts where they are grown.

The internal fruit characters of a tomato variety are revealed by transverse and longitudinal cuts through the centre. The latter reveal the extent of core develop-

Figure 1.
Transverse sections of five tomato varieties, illustrating different rating classes. 1. Washstate, 1 point. 2. Tatura Dwarf Globe, 2 points. 3. Wasatch Beauty, 3 points. 4. Pan America, 4 points. 5. Red Cloud, 5 points.

ment, a character to be avoided. In Figure 1 the transverse sections of five tomato varieties are shown, and in Table 2 the features shown by these sections are each given points out of a total of five. In the last column of Table 2 the overall ratings

TABLE 2.

An Analysis of the Composite Internal Fruit Features which have placed the Varieties of Figure 1 in the Five Different Rating Classes.

Variety.	Average Number of Cells.	Percentage of Flesh. Points 0–5.	Percentage of Cells Filled. Points 0–5.	Absence of Core. Points 0–5.	Overall Internal Fruit Characters. Points 0–5.
1. Washstate	4–5	3	3	2	1
2. Tatura Dwarf Globe	4–5	3	4	5	2
3. Wasatch Beauty ..	6–8	3	4	3	3
4. Pan America ..	5–6	4	4	5	4
5. Red Cloud	10–11	5	4	5	5

out of five for the internal fruit characters of the five varieties are given. This shows how the points for the internal fruit characters of the varieties in Table 1 were deduced.

One point is given for varieties soft to the feel and showing on cutting a few large cells not always particularly well filled with juice and seeds, the centre often having marked core development. Varieties gaining two points have much the same

characters as the previous group but have no core development, and the internal cells are usually well filled with juice. Three points are given to varieties with more complex cell development, and which are firmer but still relatively juicy and as a defect often have core development. Many of the so-called Chinese varieties like Rouge de Marmande and Adelaide Dwarf Red come into this class. The class receiving four points for internal characters are typified by many well known canning sorts such as Marglobe, Riverside, Pan America and Stone. In this group the number of cells is similar to the previous class, but core development is usually absent and the percentage of flesh is higher, with the result that the fruit is firm and desirable for canning. Pearson should be included in the group receiving five points, but core development and a tendency sometimes to coarseness result in it being placed in the four point group. Five points are given to those varieties with a relatively large number of small cells distributed across a section showing a high percentage of flesh, and with no core development. Grosse Lisse, Break o' Day and Indiana Baltimore are representative of this grade.

It has been found by parallel studies that the internal fruit characters of varieties raised from the same lines of seed at such widely differing places as Canberra, Merbein, and Katherine are remarkably stable. Random observations in a wide range of other districts have confirmed this conclusion. It is considered that a study of internal fruit characters in relation to processing, and ability to stand up to transport to market would be well worth while. Varieties like Pearson and Grosse Lisse have a relatively complex cell development with a high percentage of flesh, and, as a result, are firm and process well and can be transported quite long distances without undue breakdown. On the other hand, Tatura Dwarf Globe, with its smaller number of cells and juicy interior, is risky to transport and for best results needs to be canned close to the production site. It is admitted that if a variety possesses a very tough skin this will counteract to some extent the disadvantage of a watery interior.

The problem of flavour has not been discussed as it is very difficult to draw conclusions from the observations which have been made. It has been found that some tasters show a decided preference for some varieties, whereas many seem to have no particular likes or dislikes.

The Bush Types Found Among Tomato Varieties.

As previously explained, there has been a decided swing away from the so-called indeterminate varieties, to determinate or self topping ones, both in this country and overseas. As a result, in this study varieties have been judged in accordance with these trends. It is admitted that there will always be a certain demand for indeterminate, staking varieties from home gardeners, and from market gardeners growing tomatoes under more humid conditions where unstaked determinate varieties would by comparison, suffer more severely from fruit rotting and other troubles.

In Figure 2 is shown the bush of a representative indeterminate variety, Stokesdale, in comparison with that of a Pearson selection. The bush type possessed by the Pearson selection is considered ideal in that it is compact, stands up well, and provides adequate leaf coverage for the developing fruit which is held well off the ground. It is ideal for hot irrigated conditions under which the largest acreages of tomatoes in Australia are grown. Other determinate varieties like Tatura Dwarf Globe and Adelaide Dwarf Red are given four points for bush type in the classification of Table 1, since their fruit tends to be exposed. Bounty and Rouge de Marmande are given three points for bush type as the fruit is often much exposed. Although fruit exposure is not such a defect under cool conditions, it is considered a definite drawback in a hot environment where exposed fruits become scalded in the sun and do not ripen properly. Exposure of the fruits, whether in a cool or hot environment, results in an excessive development of yellow pigment in the skin so that mature fruits often appear unripe. Adequate leaf coverage results in the normal development

Figure 2.
Bush types of Stokesdale (above), 3 points, and Pearson Selection (below), 5 points.

of red skin pigment. Many of the better indeterminate varieties of tomatoes like Bonny Best and Stokesdale have quite a fair bush type and have been given three points for this character. At the other extreme, cluster varieties like Potentate with rambling growth and rather poor leaf coverage have been given two points.

Conclusions.

This study has emphasized the paucity of all-round, really good varieties, and the relatively large number of mediocre ones in existence. By careful study of the agronomic characters which compose a good commercial variety it should be comparatively easy for a plant breeder to synthesize superior new varieties from available material. For the bulk of future tomato growing in Australia, new varieties need to possess

(1) earliness ;

(2) high yielding ability which is strongly correlated with the ability to set fruit under a wide range of conditions ;

(3) a smooth, bright red, globular fruit free from any inherent tendency to develop blemishes such as stylar end scar and radial cracks, and possessing a relatively tough skin ;

(4) an internal structure with a relatively large number of cells, a high percentage of flesh and a complete absence of core development ;

(5) a determinate, compact and sturdy bush, habit with a good leaf coverage for the fruit ; and

(6) good field resistance, particularly to Fusarium wilt and Early Blight.

The problem of disease resistance has not been stressed particularly, since the largest irrigated tomato areas of Australia are remarkably free from serious disease. In irrigated districts with a sandy soil, Fusarium wilt sometimes becomes troublesome, so that resistance would be a distinct advantage in any new variety. Virus diseases like spotted wilt and big bud are sometimes rather evident in the big commercial areas, but it is hoped that these will eventually be controlled by eliminating their insect vectors by spraying with materials similar to D.D.T. Disease and insects may become limiting factors in the more humid areas of Australia, particularly at certain times of the year.

Most of the better varieties have been enumerated in Table 1. Among recently introduced varieties the following are considered promising : Red Cloud, Sioux, Tatinter, Pennheart, Valiant and Morse's Special Early. Others which have little to commend them are : Bison, Early Chatham, Extra Early Harkness, Coventry, Jubilee, Nystate, Stemless Pennred and Pennorange, Table Talk, Victor, Washstate and Wasatch Beauty.

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TECHNICAL NOTES

PROTECTION OF PLANTS FROM BLACK BEETLE BY DDT APPLIED TO THE SOIL.

In November 1944 it was noticed that adults of the Dynastid *Heteronychus sanctæ-helenæ* Blanch. showed marked toxic symptoms when placed in jars containing soil mixed with DDT-pyrophyllite dust. The concentration of DDT was less than one part per 1,000 by weight, which suggested that crop protection by DDT as a soil dressing might be economically possible, especially if the treated soil could be localized round the plants.

Experiment with Marigolds.

An opportunity to test such a treatment presented itself when black beetle was found killing many plants in a well-grown commercial crop of marigolds at Cronulla. Into the places formerly occupied by 42 advanced plants which had succumbed to beetle were planted 42 marigold seedlings ; half of these replacements were planted with DDT in the soil, while the other half were planted in untreated soil.

Arrangement. The death of the original plants had followed no regular sequence or pattern in the rows, so that regularity in the grouping of replants was impossible and conventional plot layout could not be adopted. Instead the 42 replant seedlings were set out along the rows wherever vacant spaces occurred, each alternate seedling being planted with DDT in the soil.* This meant that in many places the seedlings were separated by one or more of the large original plants ; nevertheless it was considered that this layout would subject each set of 21 plants to a substantially equal share of the infestation prevailing.

Planting Procedure. Treated Seedlings. The dibble holes were filled with water. When this had drained away the seedlings were planted as in Figure 1. using fine

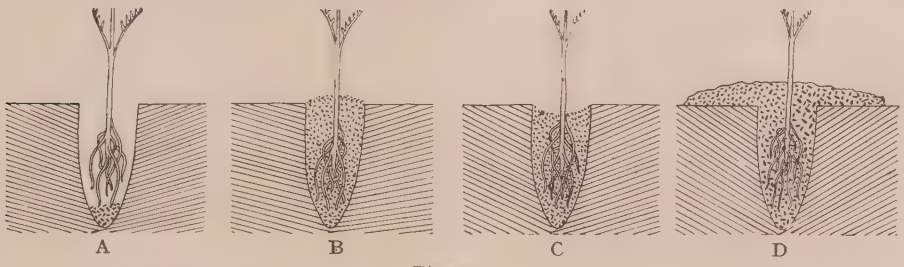

Figure 1.

Hatching = untreated soil.
Stippling = treated soil.

Method of planting seedling with treated soil.
A and B. Stages in filling hole with treated soil.
C. Treated soil firmed down around plant.
D. Additional treated soil around base of plant.

soil which had been thoroughly mixed with 4 per cent. DDT-pyrophyllite dust at the rate of 9·9 oz. dust to one gallon of soil. When planted the seedlings were again watered. One gallon of soil, augmented by 9·9 oz. of dust, sufficed for the planting of about 13 seedlings. Details of this method of planting are published elsewhere.(1)

Control seedlings were planted as above except that nothing was added to the fine soil used in planting.

* Unimportant departures from this sequence occurred in two parts of the crop where the same treatment was inadvertently applied to two adjacent instead of alternate seedlings.

Results. The seedlings were planted out on 14th February and grew in healthy fashion except for those adversely affected by black beetle. The condition of the plants was observed 7, 12, 14, 22, 29 and 34 days after planting out (see Table 1). On 20th March, 34 days after planting out, all surviving plants were dug up in order to assess the amount of injury where it chiefly occurs—below ground. The results are summarized in Tables 1 and 2.

TABLE 1.

Effect of Soil Treatment with DDT on Black Beetle Infestation of Marigolds.

Condition of the Plants as Judged by the State of their Above-ground Parts.

	Treated Plants.						Control Plants.					
	Feb. 21	Feb. 26	Feb. 28	Mar. 8	Mar. 15	Mar. 20	Feb. 21	Feb. 26	Feb. 28	Mar. 8	Mar. 15	Mar. 20
No ill-effects. No above-ground nibbling*	21	20	19	14	17	13	9	10	10	10	11	8
No ill-effects. Light above-ground nibbling	Nil	1	2	5	2	5	Nil	Nil	Nil	Nil	Nil	Nil
Showing ill-effects due to black beetle	Nil	Nil	Nil	2	2	3†	9	4	2	2	1	4
Dying from black beetle injury	Nil	Nil	Nil	Nil	Nil	Nil	2	3	2	Nil	Nil	Nil
Dead (total to date): all killed by beetle	Nil	Nil	Nil	Nil	Nil	Nil	1	4	7	9	9	9

* This term refers to the beetle's secondary and less typical feeding habit, of minor agricultural importance (see p. 137).
† Only 3 plants out of 21 showed ill-effects; these 3 were affected (2 wholly and 1 chiefly) by "above-ground nibbling"

TABLE 2.

Effect of Soil Treatment with DDT on Black Beetle Infestation of Marigolds.

Condition of the Plants' Below-ground Parts when dug out on 20th March, five weeks after planting out.

	Treated Plants.	Check Plants.
Perfect (no beetle injury whatever)	13	5
Very good (negligible to very light injury)	6	1
Good (light to moderate beetle injury)	2	0
Fair (moderate to heavy beetle injury)	0	2
Poor (heavily injured by beetle)	0	2
Almost useless (almost obliterated by beetle)	0	2
Dead (killed by beetle 21st February-8th March)*	0	9
Total	21	21

* As each plant died it had been dug up, removed and examined to ascertain cause of death.

Conclusions. (*a*) In this experiment the DDT-pyrophyllite treatment gave a high degree of crop protection for some weeks under conditions where beetle activity was sufficient to kill or severely injure more than half the control plants. (*b*) Treated plants showed no toxic symptoms due to the presence of the chemical in the soil. (*c*) The treatment did not control the beetles' relatively unimportant above-ground feeding activities.

Experiment with Cauliflowers.

Soil impregnation with DDT was further tested on cauliflowers at Sutherland. The first phase of this experiment was a trial of DDT-pyrophyllite dusts in the soil; the second phase aimed at testing the effect of DDT emulsion as a soil drench.

Phase I.

This phase began when the seedlings were planted out and ended $3\frac{1}{2}$ weeks later when the plants were hilled up.

Treatments. The following treatments were compared on a total of 180 plants in five randomized blocks :

(*a*) *DDT, heavy dressing.* Seedlings planted with fine soil mixed with 3 per cent. w/w DDT-pyrophyllite dust (1 lb. dust to one gallon soil).

(*b*) *DDT, light dressing.* Seedlings planted with fine soil mixed with 1·4 per cent. w/w DDT-pyrophyllite dust (1 lb. dust to one gallon soil).

(*c*) *Control (no DDT).* Seedlings planted in fine soil only.

It was found that one gallon of soil, augmented by 1 lb. of dust, sufficed for 14 to 16 seedlings.

The 180 seedlings were planted out on 3rd-5th March* in conformity with the technique shown in Figure 1. Overhead spray irrigation was applied at intervals and the whole crop was dusted at various times for the control of cabbage moth and aphis.

Within a day or two of planting out there were abundant signs that black beetle was active and widespread through the crop and this activity continued at a satisfactory level for about three weeks, by which time the plants were believed to be outgrowing their susceptible seedling stage (Wallace[2]).

Feeding Habits of the Pest. In cauliflowers black beetle has two distinct feeding habits :

(*a*) *Underground Attack.* This is the normal and typical feeding habit of the species which makes it a pest : a partial or complete destruction of the taproot or stem below ground causes wilting or collapse, often followed by death of the plant or long continued dwarfing.

(*b*) *Above-groung Nibbling.* In this secondary and much less typical feeding habit the plant is nibbled just above-ground (sometimes right at soil level). In cauliflowers the scars callus very quickly and the plants suffer no discernible setback. Exceptions to this rule are so rare that the writer considers this scarring to be agriculturally unimportant. Entomologically, however, these scars provide a very useful guide to the distribution of beetle activity through a crop.

Results. The relative value of the treatments may be gauged from Table 3.

TABLE 3.

Effect of Soil Treatment with DDT on Black Beetle Infestation of Cauliflowers.

	Condition of the Seedlings $3\frac{1}{2}$ Weeks after Planting Out.			Subsequent Changes.
——	DDT Heavy Dressing.	DDT Light Dressing.	Control.	
Killed by beetle injury underground	Nil	Nil	10	——
Dying from beetle injury underground	Nil	Nil	1	Dead by 18th May.
Dwarfed ; beetle wholly or partly responsible	Nil	Nil	1	Still poor and dwarfed 1st June.
Almost killed by above-ground nibbling	Nil	Nil	1	Eventually recovered.
Healthy and vigorous. No apparent ill-effects despite above-ground nibbling in many plants ..	60	60	47	——

* Each day's planting comprised an equal number of seedlings in every plot of the experiment.

The table summarizes all actually harmful effects of the pest observable in the crop up to $3\frac{1}{2}$ weeks after planting out. This period was chosen for two reasons: (i) that it is thought to cover all or most of the period during which cauliflowers are susceptible to black beetle, and (ii) because treatments (*a*) and (*b*) were necessarily terminated when the plants were hilled up late in March (see Phase II).

The 13 affected plants listed in Table 3 were distributed between the five control plots as follows: 4, 2, 2, 3, 2. Further evidence of well-dispersed infestation was seen in the marks of above-ground nibbling, which occurred on about 45 per cent. of plants in each of the three treatments (*a*), (*b*) and (*c*).

Throughout Phase I the healthy appearance and vigorous growth of all DDT-treated plants made it obvious (i) that underground beetle damage to those plants must be absent or at most negligible, and (ii) that there was no visible phytotoxic effect.

Conclusions. It can be said that treatments (*a*) and (*b*) gave about $3\frac{1}{2}$ weeks' good protection of cauliflower seedlings against a beetle infestation severe enough to kill or grossly damage about 20 per cent. of the untreated controls.

Phase II.

In the fourth week of March the entire crop was hilled up so that the upper few inches of each stem, instead of projecting above-ground, were now surrounded by fresh soil. This heaping of DDT-free soil around part of each stem automatically destroyed the effect of treatments (*a*) and (*b*), thus terminating the conditions of Phase I.

The 180 experimental seedlings were then used in an attempt to gain all possible information on the suitability of DDT spray as a soil drench against black beetle. It was realized that this test would probably fail to yield data on pest control because of the age of the seedlings; nevertheless, the test was undertaken in the hope that it would at least determine whether the proposed soil treatment was harmful to plants.

Treatments. The crop was hilled up on 26th-27th March. As soon as each row of plants was hilled, the soil around each stem was deeply drenched by a jet of liquid applied from a knapsack sprayer. All plots which in Phase I received treatments (*a*) and (*b*) were jetted with a dilute emulsion prepared by adding water to a stock solution of DDT in solvent naphtha with " Wetsit " added. The final spray mixture contained 0·08 per cent. w/v of DDT and 0·5 per cent. v/v of solvent naphtha. All plots which received treatment (*c*) in Phase I were retained as control plots and were jetted with water only.

Results. (*a*) As was anticipated, Phase II supplied no evidence on the protective value of DDT applied as a drench because no further signs of beetle attack appeared, even in the controls.

(*b*) One plant whose taproot had been all but severed by accidental mechanical injury showed strong toxic symptoms which were attributable to the emulsion. The other 119 plants treated with emulsion showed no toxic symptoms; in size and appearance they were at least equal to the surviving plants in the control plots.

(*c*) The writer on 21 consecutive days ate without ill effect an average daily portion of 8·2 oz. of cauliflower cut from plants which in Phase I had received treatment (*a*) and in Phase II the DDT emulsion.

(*d*) It was noticed in July that earthworms were plentiful in all plots of the experiment.

Conclusion from Phase II. Injection of soil with DDT emulsion as used is worthy of further trial in experiments.

Discussion.

It is clear that the DDT treatments outlined in the first experiment and in Phase I of the second will enable a grower to secure a sound crop of marigolds or

cauliflowers in face of reasonably severe beetle attack. However, the beetle's range of host plants is extremely wide and there are indications that at least one of these hosts (viz. tomatoes) might react adversely to certain levels of DDT in the soil. Again, until something is known of the rate of breakdown of DDT in the soil one cannot dismiss the possibility that too frequent applications might eventually produce harmful accumulations. It is the writer's opinion that more work should be done on the indirect effects of DDT in the ground before its use as a soil dressing can be recommended.

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Entomological Branch,
Department of Agriculture,
Sydney, N.S.W.

C. R. WALLACE.

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EXPERIMENTS ON THE CONTROL OF THE BEAN SEED WEEVIL.

Results are presented in this paper of two experiments in which various dusts were evaluated for their efficiency in protecting bean seed against the attack of *Bruchus* (*Acanthoscelides*) *obtectus* Say.

Experiment 1.

Methods. The first experiment was commenced during April, 1943. There were twenty treatments, each treatment replicated three times. The seed used was first heat-treated at 125° F. for three hours to destroy any natural infestation.

The method used in this experiment was adopted with the object of introducing the infestation in as many ways as possible, viz. by heavily infested seed, by adult bruchids and by eggs plus newly-hatched larvæ. By using a red-seeded variety of bean seed for test and a brown-seeded variety as seed inoculum no confusion resulted when the results were recorded.

For each of the 60 samples, 175 gm. of clean "Canadian Wonder" bean seed and 25 gm. of the heavily infested "Brown Beauty" seed inoculum were used. The required amount of dust was shaken with the seed in a clean jar. The samples were then transferred to labelled calico bags and 0·6 gramme of etherized adult beetle screenings (averaging 35 live bruchids) added to each bag together with 0·2 gramme of another screening containing eggs and newly hatched larvæ.

After tying the bags tightly they were placed on a wooden table in a glasshouse, each about three inches apart, and the numbers properly randomized for position.

Results. Treatments were evaluated at the end of a five months' period, by which time two generations of adults had emerged.

The figures obtained in this experiment are based upon counts of two lots of 100 seeds from each of the 60 sample bags. Table 1 shows the results obtained, expressed as the number of adult weevils emerged per 100 seeds. Counts were made both of the number of emergence holes in each sample and of the percentage of infested seed. The results obtained by these different methods were subjected to a correlation test and showed highly significant correlation.

For the purpose of analysis the square root transformation was used. The standard deviation was 2·20. For significance a difference of 3·62 was required as between transformed means.

Treatments are arranged in order of merit, i.e. in order of increasing transformed mean number of emergences per 100 seeds, and the significant differences tabulated

in Table 1. Any treatment is regarded as significantly different from another if the treatments in question are not bracketed vertically by any of the bracket-lines as drawn.

TABLE 1.

Effect of Dusts on Bean Seed Weevil, Experiment 1.

Treatment.		Emergences per 100 Seeds.		Significance at Odds 1 : 19.
		Actual Mean.	Transformed Mean.	
Copper oxychloride	8 oz./bus.	0·0	0·00	
,, ,,	4 oz./ ,,	0·0	0·00	
,, carbonate	8 oz./ ,,	0·0	0·00	
,, oxychloride	2 oz./ ,,	1·7	1·00	
,, carbonate	4 oz./ ,,	2·8	1·25	
Sodium fluosilicate	4 oz./ ,,	7·8	1·49	
,, ,,	8 oz./ ,,	2·8	1·84	
Pyridine-kaolin (1 : 20)	1 lb./ ,,	10·0	3·01	
Sodium fluosilicate	2 oz./ ,,	9·0	3·30	
Copper carbonate	2 oz./ ,,	26·0	3·79	
Kaolin No. 300	1 lb./ ,,	36·3	5·54	
Sulphur-lime (1 : 1)	1 lb./ ,,	42·0	6·27	
Dolomite	1 lb./ ,,	73·3	8·11	
Lime	1 lb./ ,,	90·7	9·40	
Derris-kaolin (1 : 7)	1 lb./ ,,	107·0	10·19	
Magnesite	1 lb./ ,,	125·3	11·17	
,,	8 oz./ ,,	137·0	11·67	
,,	4 oz./ ,,	462·7	21·44	
Naphthalene	1 oz./ ,,	578·5	23·70	
Check	—	1022·8	31·92	

Treatments having an actual mean count of 10 or less were further analysed on a $^2\sqrt{x+\frac{1}{2}}$ transformation. The standard deviation was 0·70 and significant difference 1·18. The results are shown in Table 2.

TABLE 2.

Analysis of Ten Best Treatments, Experiment 1.

Treatment.		Transformed Mean.	Significance at Odds 1 : 19.
Copper oxychloride	8 oz./bus.	0·71	
,, ,,	4 oz./ ,,	0·71	
,, carbonate	8 oz./ ,,	0·71	
,, oxychloride	2 oz./ ,,	1·35	
,, carbonate	4 oz./ ,,	1·59	
Sodium fluosilicate	4 oz./ ,,	1·80	
,, ,,	8 oz./ ,,	1·98	
Pyridine-kaolin (1 : 20)	1 lb./ ,,	3·10	
Sodium fluosilicate	2 oz./ ,,	3·38	

Experiment 2.

Methods. The second experiment was set up in March, 1945, and comprised 10 treatments with four replications per treatment.

A method similar to that used in Experiment 1 was adopted with the exception that samples comprised 100 gm. of bean seed, and the inoculum 2 gm. of etherized screenings from infested seed, estimated to contain an average of 30 live adult

bruchids in addition to frass and some eggs. The samples were kept in an incubator at 70° F. At the conclusion of the experiment in July, 1945, counts were made on 100 seeds at random per sample and results are expressed as percentage of holed seed.

Results. Since, in this case, the five best treatments yielded figures obviously significantly different from the other treatments, the $\sqrt{x}$ analysis was applied to the latter treatments only.

The standard deviation was 0·66 and a difference of 1·00 was required for significance between the transformed means at odds 1 : 19. The results are shown in Table 3.

TABLE 3.

Effects of Dusts on Bean Seed Weevil, Experiment 2.

Treatment.		Percentage of Holed Seed.		Significance at Odds 1 : 19.
		Actual Mean.	Transformed Mean.	
*10% DDT in kaolin	1 lb./bus.	0·00		
†10% DDT on kaolin	1 lb./ ,,	0·00		
†10% DDT on pyrophyllite	1 lb./ ,,	0·00		
Kaolin No. 21	1 lb./ ,,	0·25		
Magnesite	1 lb./ ,,	2·50		
Copper oxychloride	2 oz./ ,,	9·50	3·04	
Kaolin No. 441	1 lb./ ,,	25·00	4·92	
Pyrophyllite	1 lb./ ,,	78·50	8·84	
‡Spergon	2 oz./ ,,	96·25	9·81	
Check	—	98·00	9·90	

* DDT mechanically admixed. † DDT adsorbed.

‡ Tetrachloroparabenzoquinone—fungicidal seed dust used as recommended.

Discussion.

There is no doubt that DDT will protect bean seed from attack by *Bruchus obtectus*, although 1 lb. of 10 per cent. dust per bushel appears to be an excessive application. A germination test on seed stored with DDT over the period of the experiment has been carried out. The results (using old seed) were : 36 per cent. not treated, and 34 per cent. DDT-dusted.

Three types of kaolin were used in these tests. These were supplied by McLeod and Co., Sydney, who state that there is no difference in particle-size between the samples. The superiority of No. 21 (origin, Mudgee, N.S.W.) is very marked. Nos. 300 and 441 (Sydney district) are heavier. While No. 21 adhered well when mixed with the seed, No. 441 did not. In the same way pyrophyllite, a heavy dust, also gave poor adherence and was largely not taken up by the seed.

While a magnesite of unknown origin gave poor control in the first experiment, the magnesite used in the second experiment gave excellent control. The latter magnesite is the only one now handled by McLeod and Co.

"Spergon", the recommended fungicidal seed dust for beans, showed no promise for control of bean seed weevil.

A. H. FRIEND.

Entomological Branch,
Department of Agriculture,
Sydney, N.S.W.

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The Australian Institute of Agricultural Science

MEETING OF COUNCIL.

A Council meeting was held at Science House, Gloucester Street, Sydney, on 5th June, 1945, and was continued on the following day.

Present.—The President, Dr. B. T. Dickson (in chair), Dr. J. R. A. McMillan (A.C.T.), Dr. E. T. Edwards (N.S.W.), Mr. R. D. Croll (V.), Dr. N. S. Noble (Q.), Dr. H. J. Hynes (S.A.), Mr. G. de Vahl Davies (W.A.), Mr. R. H. Anderson (T.), the Hon. General Treasurer, Mr. F. C. McCleery, and the Hon. General Secretary, Dr. F. T. Bowman.

Although the office of Messrs. Cleveland, Son and Hislop, 20 Queen Street, Melbourne, will remain the registered office of the Institute, it was resolved that while the office of management remains in Sydney, Messrs. Horley and Horley be the Institute's auditors.

Council agreed that it was a function of the Institute to sponsor conferences on technical subjects relating to agriculture and resolved to sponsor a conference of plant breeders and geneticists to be held in Sydney. A sub-committee consisting of Mr. F. C. McCleery (convenor), Dr. S. L. Macindoe and Dr. I. A. Watson was appointed to implement this resolution.

Actions taken in respect to items from the seventh general meeting, viz. returned soldier preference, salaries of scientific agricultural personnel, the proposal to publish an *Australian Journal of Agricultural Science*, and the functioning of proxy Council, were reported to Council. Sub-committees were set up to consider the general matter of Institute publicity and to frame by-laws for the election of president.

A report from the Business Manager of the Journal (Mr. N. C. Lloyd), together with audited statements of receipts and expenditure for Volume 10, were received. A summary of the Business Manager's report appears below.

Details involved in transferring the office of publication of the journal to South Australia were discussed, and it was intimated that the recently appointed Publications Committee would assume responsibility for the preparation and production of Vol. 11, No. 3, and later numbers. The committee was authorised to bring Vol. 11 up to 208 pages plus an index.

The Hon. Secretary advised that 16 applications for membership had been forwarded to the Qualifications Committee. The following transfers were noted: Mr. N. H. Shaw (V.) to Queensland Branch; Mr. D. C. Wark (A.C.T.) to N.S.W. Branch.

A report from the Institute's auditors, Messrs. Cleveland, Son and Hislop, with statements of income and expenditure and the balance sheet for the year ending 31st December, 1944, were received. These statements appear on page 143.

Summary of the Report of the Business Manager of the Journal for Vol. 10 (1944).

Dr. Noble resigned from the position of Business Manager during the year, and was succeeded by Mr. Lloyd.

Paper rationing continued to cause concern throughout the year. At one stage it appeared that it would be necessary to print the Journal on newsprint, but, as the result of representations by the former Business Manager, permission to retain the present quality of paper was secured. The current paper quota will enable publication of the 800 copies required only if individual issues do not exceed 48 pages.

During the year the circulation of the Journal increased considerably, and passed the 700 mark. This was brought about by an increase in the number of Institute members and a net increase of 17 in the number of subscribers. Subscribers accounted for 80 copies of Vol. 10 (Australian, 51; British, 13; and foreign, 16). In addition, 55 copies were distributed to libraries and for review and copyright purposes (Australian, 21; British, 22; and foreign, 12).

Comparative costs of printing the Journal for 1943 and 1944 were as follows:

	Vol. 9 (1943) £ s. d.	Vol. 10 (1944) £ s. d.
Printing, etc.	187 7 6	189 13 0
Blocks	17 10 1	7 18 0
Index	4 4 0	4 4 0
	£209 1 7	£201 15 0

The gross cost of publishing Vol. 10 amounted to £287 17*s.* 8*d.*, a decrease of £8 8*s.* 7*d.* for the year. Total receipts for subscriptions and sales amounted to £94 0*s.* 9*d.*, so that at the close of the year the net cost to the Institute of printing and publishing the Journal was £193 16*s.* 11*d.* As a few small amounts for reprints were outstanding at the close of the period, the actual net cost will be somewhat lower than the above amount.

THE AUSTRALIAN INSTITUTE OF AGRICULTURAL SCIENCE.

Income and Expenditure Account for Year Ended 31st December, 1944.

EXPENDITURE.

1943 £ s. d.		£ s. d.	1944 £ s. d.
215 1 9	To Cost of Journal		183 16 11
35 17 4	,, Printing and Stationery		44 18 6
8 8 0	,, Audit Fees		8 8 0
11 13 5	,, Petty Cash and Incidentals		14 15 8
	,, Grants to Branches—		
39 6 6	Victoria	42 1 6	
28 6 6	New South Wales	26 13 6	
12 13 0	South Australia	18 3 0	
12 18 0	Queensland	14 6 0	
14 0 6	Western Australia	19 5 0	
3 6 0	Australian Capital Territory	12 7 6	
2 15 0	Tasmania	4 2 6	
			136 19 0
384 6 4	,, Total Expenses for Year		388 18 1
60 12 3	,, Surplus for Year		71 6 11
£444 18 7			£460 5 0

INCOME.

1943 £ s. d.		£ s. d.	1944 £ s. d.
	By Victorian Branch, Subscriptions—		
32 11 0	Arrears	3 3 0	
117 12 0	Current	126 0 0	
			129 3 0
	,, New South Wales Branch, Subscriptions—		
9 13 0	Arrears	11 11 0	
99 15 0	Current	95 16 0	
			107 7 0
	,, South Australian Branch, Subscriptions—		
3 3 0	Arrears	—	
45 3 0	Current	45 2 0	
			45 2 0
	,, Queensland Branch, Subscriptions—		
16 16 0	Arrears	11 11 0	
32 11 0	Current	28 7 0	
			39 18 0
	,, Western Australian Branch, Subscriptions—		
3 3 0	Arrears	6 11 0	
50 18 0	Current	64 19 0	
			71 10 0
	,, Australian Capital Territory Branch, Subscriptions—		
1 1 0	Arrears	13 13 0	
11 11 0	Current	23 2 0	
			36 15 0
	,, Tasmanian Branch, Subscriptions—		
10 10 0	Arrears	5 5 0	
10 11 7	Current	10 10 0	
			15 15 0
	,, Interest		14 15 0
£444 18 7			£460 5 0

Balance Sheet as at 31st December, 1944.

LIABILITIES.

1943 £ s. d.		£ s. d.	1944 £ s. d.
	Sundry Creditors—		
133 2 0	Branch Grants	153 14 6	
9 7 2	General	12 6 3	
			166 0 9
4 4 0	Subscriptions Paid in Advance		4 4 0
682 1 2	Accumulated Fund at 1/1/44	742 13 5	
	Add Surplus for Year to 31/12/44	71 6 11	
			814 0 4
£889 6 7			£984 5 1

ASSETS.

1943 £ s. d.		£ s. d.	1944 £ s. d.
	Cash at Bank—		
234 8 11	Melbourne	403 17 8	
20 4 2	Sydney	3 7 0	
			407 4 8
100 0 0	Fixed Deposit		100 0 0
100 0 0	Commonwealth Govt. Bonds 3½%, due 15/8/1956		100 0 0
100 0 0	Commonwealth Govt. Bonds 3½%, due 15/11/1958		100 0 0
200 0 0	Commonwealth Govt. Bonds 3½%, due 15/9/1959		200 0 0
6 12 6	Interest Accrued		4 5 0
117 6 0	Subscriptions Outstanding (since collected)		60 7 0
9 5 0	Office Furniture		9 5 0
1 10 0	Petty Cash in Hand		3 3 5
£889 6 7			£984 5 1

These are the Statements referred to in our Report dated 11th May, 1945.

CLEVELAND, SON & HISLOP,
Chartered Accountants (Aust.).

MEETINGS OF BRANCHES.

New South Wales Branch.

At a general meeting on 11th May, 1945, members heard an address on "Agricultural Requirements in the Far East", by Mr. F. W. South, United Kingdom representative, and Acting Chairman of the UNRRA Technical Sub-committee on Agriculture in the Far East Region. Mr. South delineated the boundaries of the Far East Region for UNRRA purposes and pointed out that some countries, notably Great Britain, U.S.A. and France, had agreed to undertake relief and rehabilitation in their former territories without help from UNRRA. The agricultural activities of practically all the countries where UNRRA would be working revolve around rice. Factors likely to hinder the rehabilitation of the rice industry in Far Eastern countries are (*a*) the condition of internal transport, (*b*) the state of agricultural implements, (*c*) the shortage of draught animals, (*d*) the lack of containers for transporting rice, (*e*) damage to milling machinery, (*f*) the attitude of peasant proprietors who will be difficult to persuade to grow more rice than is needed for domestic purposes.

In discussing the possibility of cultivating additional rice land over and above the area that could be sown with existing facilities, Mr. South said that mechanical cultivation had not been introduced in the past because (*a*) high rainfall and inability to control water on rice fields precluded the use of heavy machinery, (*b*) the bays were small, which meant much turning and uneconomical running if tractors were used, (*c*) unless the price of rice was very high it was uneconomic to use machinery for rice alone. Mr. South said, however, that large-scale mechanical cultivation of rice on experimental areas would be worth trial, particularly in parts of Burma and China. A proportion of the implements needed might be secured from Australia. Burma intended to purchase 500 tractors expressly for the cultivation of ground nuts, but they could be diverted for alternative uses. China had ordered 3,000 tractors, for use in reclaiming the Yellow River Valley. Netherlands East Indies hoped to secure 300 tractors for agricultural purposes.

In addition to agricultural machinery, Mr. South listed the following requirements: seed of temperate climate vegetables, tobacco and cotton, fertilizers and pesticides, limited numbers of livestock—pigs, goats, poultry, sheep and dairy cattle—to reestablish dairy farms at Hong Kong and Singapore.

Mr. South said in respect to food substitutes for rice that the possibilities had been examined and it had been found that cracked wheat might be effective when put through coarse rollers and cooked in the same manner as rice. Australian wheat supplied to New Guinea natives had been fairly well received. However, the native population of most of the countries concerned would not consume finely-ground wheat or flour. Northern China was a possible exception.

In reply to questions Mr. South said that a separate organization is concerning itself with rehabilitation problems in the rubber plantation industry. UNRRA is concerned with general agricultural rehabilitation and is taking steps to re-establish the manila hemp and other fibre industries, the textile industry in China, and tobacco production, but it is primarily concerned with the food problem.

The main item at the general meeting held on 13th July, 1945, was a symposium, "Industrial Uses of Farm Products", to which Messrs. R. D. Croll, W. Poggendorff and H. H. Eager contributed. Mr. Croll introduced the subject with information on the many and varied products of chemurgy. Mr. Poggendorff dealt with the potentialities of N.S.W. crops for the purposes of industrial processing. Mr. Eager dealt with technical and chemical aspects and gave some consideration to economic factors. Several visitors from processing and business firms took part in the subsequent discussion. They urged the Institute to sponsor machinery for closer liaison between parties concerned in production and in the industrial use of farm products, so that the possibilities of further outlets for these products would not be missed.

South Australian Branch.

Dr. T. Eden, of the Tea Research Institute of Ceylon, addressed the branch meeting of 18th May, 1945, on "Agricultural Problems in Tea Culture". After giving an outline of tea-growing methods, Dr. Eden drew attention to technical problems facing the industry in Ceylon. Methods used to minimize soil erosion on the steep slopes were described, and mention was made of the difficulty experienced in finding plants which would provide ground cover without growing into the tea bush among the leaf crop. Responses of the tea plant to nitrogen after the first year of the pruning cycle were described as spectacular. Smaller effects are obtained with phosphate, but no benefit is obtained with potash or any of the trace elements. Reference was also made to a failure to grow normally after pruning due to a carbohydrate deficiency in plants grown at certain altitudes and necessitating a reduction of the severity of pruning. Dr. Eden also explained the importance of certain methods of clonal propagation which had been developed for the extension of improved varieties. Complete control of a Tortrix caterpillar (*Homona cafferia*, sub-species *theæ*) had been achieved by means of a parasite (*Macrocentrus*) from Java, and some control of a shothole borer (*Xyleborus fornicatus*) had also been achieved by cultural treatments. The sole virus disease so far encountered in Ceylon on tea was found to produce symptoms only on certain varieties, although varieties which showed no symptoms could transmit the disease to grafted scions obtained from susceptible stock.

Mr. O. Bowden addressed the Branch on 28th July on the subject " Problems of Agriculture in Cereal Districts in Relation to Reconstruction ". Basing his remarks on his personal knowledge of the district and on an analysis of 281 farms in the Riverton district of the Lower North, the speaker discussed changes in agricultural practice that had taken place during the past twenty years.

The specialized wheat farming of the past was based on exploitation, and there were several difficulties to be overcome in developing a stable diversified system. Foremost among these was the need for providing a more adequate education for country children with a rural rather than a professional bias. This was essential if extension work was to bridge effectively the gap between science and practice.

Other problems awaiting attention were those of readjusting rural debts and the raising of the general standard of living in country districts.

Western Australian Branch.

At a general meeting on 26th June, the President reported on actions taken by the committee in respect to matters raised at the seventh general meeting of the Institute. There was plenty of discussion concerning the all-Australian agricultural policy, and the attitude taken by the committee, endorsed.

Two short addresses were delivered during the evening : Dr. L. W. Samuel spoke on " The Influence of Crop Rotation and Fertiliser on Wheat ' Strength ' ", and Mr. R. C. Rossiter on " Veldt Grass ".

Dr. Samuel described the results of tests with wheat from various experiments at the Department of Agriculture's research stations during 1944. These experiments were primarily designed to test the effect of the experimental conditions on yield but since samples of the wheat produced were available they were tested for " strength ". The Pelshenke test for grain, the gluten test and the Farinograph (a recording dough mixer) for the flour were used. Data was also obtained on the water absorption of the different flours, since this quality is of economic importance to the baker.

It was found that the application of phosphate fertilizers in " rate of application " trials at four centres did not affect " strength ".

A similar result was obtained from the " residual superphosphate " experiment at three stations, but at the fourth, Chapman Research Station, the use of superphosphate had reduced " strength ".

The use of a fertilizer containing molybdenum at Merredin reduced " strength ", but when several minor elements were used together, " strength " was markedly increased.

At Merredin with two varieties a " change of seed " from three other stations did not affect " strength ".

Wheat from rotation experiments at three stations gave differing results, though in each case improved " strength " was obtained by introducing one or more courses in the rotation.

At Chapman, a fallow year or a " stubble " year followed by fallow, before wheat, apparently had no effect on " strength " when compared with wheat grown continuously. But a course of two years lupins followed by fallow before wheat increased " strength " by some 50 per cent.

At Merredin, fallow before wheat increased " strength " by 20 per cent., while a year of natural pasture before the fallow caused a further 50 per cent. increase in " strength ". Two years of natural pasture followed by fallow before wheat did not promote any further improvement in " strength ".

At Wongan Hills, a fallow-wheat rotation, when compared with wheat grown continuously, resulted in a marked increase in " strength ", but a year of natural pasture before fallow, or two years of lupins before fallow, caused only a small further increase.

Investigations with perennial veldt grass (*Ehrharta calycina*) were briefly described by Mr. Rossiter. The work covered (i) *fundamental agrostological studies*, including work on seed analysis, phenology, growth-form, self- and cross-fertility, seed harvesting and the effect of frequency of cutting on productivity and chemical composition ; (ii) *field trials* at several country centres with a wide range of soils and climate ; and (iii) *a grazing trial* at the Institute of Agriculture where the effect of continuous and rotational grazing on a veldt grass-subterranean clover pasture is being examined.

Discussing the problems of seed harvesting, stress was laid on the long period over which *Ehrharta* ripens and sheds its seed which makes the collecting of seed under field conditions extremely difficult. A non-shedding type (genetically recessive) has been discovered. Its seed is retained in the glumes until December, and it is possible to harvest seed yields of the order of 400 lb. per acre.

The feasibility of increasing the use of this grass in the sheep areas was considered and various aspects of grazing management discussed.

Current Notes and News

Reorganization of Queensland Department of Agriculture.

Mr. A. F. Bell, Technical Assistant Under Secretary and Director of the Bureau of Sugar Experiment Stations, supplies the following commentary on this reorganization.

In order to provide full advisory and research facilities for primary industry in the post-war period, the Government of Queensland has recently approved a scheme for the complete reorganization of the Department of Agriculture and Stock. This scheme is now being implemented in so far as wartime staff difficulties permit : more than twenty-five per cent. of the departmental officers are still absent on defence or other national service duties, while recruitment in this, as in most other institutions, has been negligible over the past five years. Some considerable time must necessarily elapse before the proposals embodied in the scheme are brought to fruition.

Following usual procedure the activities of the Department have been sectionalized into five Divisions, namely Plant Industry, Animal Industry, Dairying, Marketing and Administrative. The permanent head, or Under Secretary, will be assisted in administration by two Assistant Under Secretaries. One Assistant Under Secretary will supervise the activities of the technical divisions (Plant and Animal Industry and Dairying), while the other will supervise the work of the Marketing and Administrative Divisions. In addition, a special administrative officer with senior status has been attached to the central administration for special and emergency duties.

In designing the structure of the technical divisions the policy has been to make them as self-contained as possible in order to facilitate close and rapid co-operation in investigational work. Moreover it was thought that such structure would foster team spirit.

The Division of Plant Industry is comprised of five branches : Agriculture (excluding sugar), Horticulture, Science, Plant Nutrition Laboratory, and the Bureau of Sugar Experiment Stations. In addition, the Director of Plant Industry will have associated with him certain specialist advisers who will be authorities on problems common to several branches, such as soil conservation, irrigation, biometrics, and so on.

The Agricultural and Horticultural branches will carry on both research and extension activities, with selected officers able to act as liaison officers between these branches and the Science Branch and the Plant Nutrition Laboratory ; for example, the Soils Chemist in the Agricultural Branch will correlate fertilizer experiments in the field with the laboratory studies in plant nutrition. By virtue of its special constitution, the Bureau of Sugar Experiment Stations will continue to maintain its own soils, pathology, entomology and applied science laboratories. In the field the above branches are organized on a district basis, with a senior adviser in charge of each district, the advisers stationed in sub-districts being under his direct control.

Included in the Science Branch will be the three sections of Pathology, Entomology and Botany, the head of one section being also the administrative head of the branch.

The Division of Animal Industry will contain the four " production " branches of Stock, Sheep, Pigs and Poultry, a Veterinary Research Branch and a Biochemical Laboratory. The State has been divided into five divisions, each in charge of a divisional veterinary officer, who, through his district officers, will control the activities of the veterinary officers, advisers and inspectors stationed within the divisional area. It is planned to place a good deal more emphasis on animal husbandry than has been possible heretofore.

The Veterinary Research Branch will incorporate the animal health stations at Yeerongpilly and Oonoonba, and plans provide for the gradual recruitment of a staff of veterinary officers, parasitologists, bacteriologists, etc., necessary for carrying out a programme of veterinary research. The biochemical laboratory, at present a component of the agricultural chemical laboratory, will be associated with the animal health stations as soon as staff and accommodation permit.

All matters of animal health, husbandry and breeding will be the responsibility of the Division of Animal Industry ; the Division of Dairying will take over at the bails, so to speak, and will be responsible for dairy hygiene, herd testing, and the problems of transport, manufacture and preservation of dairy products. This division maintains a fairly extensive and well equipped Dairy Research Branch, with one main and two subsidiary laboratories ; this Branch also carries out the technical work necessary for the control of Brisbane's milk supply.

As in the case of the two other production divisions, field organization is on the district basis, with senior advisers in charge of the local advisers and dairy officers. These officers will work in close association with butter and cheese factories and milk companies. Other sections of the division will deal with statistics, herd testing, grading of dairy products, and control of cream transport.

The Division of Marketing is as yet in a more or less embryonic stage ; the organization provides for the creation of a Marketing and Economics and a Standards Branch. The Marketing and Economics Branch will be charged with the supervision of the Primary Producers and Marketing Act, the development of organized marketing, the preparation and promulgation of market reports, and the collection and collation of production statistics, including costing. The Standards Branch will see to the maintenance of market standards, or label standards, as required by various Acts, such as the Fertilizers, Pure Seeds, Stock Foods, Pest Destroyers and Veterinary Medicines Acts. At the present time this Branch is also charged with administering the various rationing schemes.

The Administrative Division includes sections dealing with accounts, central correspondence and records, purchasing and stores, photography, publicity and general maintenance. This Division also deals with personnel and staff matters.

All branches are necessarily understaffed at present, and some are seriously so ; nevertheless, the ground plan has been set out for future building as trained or trainee staff becomes available. Linking of the many branches and sections is such that the paths of promotion and opportunities for advancement to senior executive positions will be uniform in all sections and a determined effort has been made to avoid " dead-ends ". A deputy has been provided in most branches so that continuity of direction will be obtained.

All positions have been reclassified as to salary and the salaries now paid compare well with the Public Services of other States. Automatic progression in the professional sections has been materially improved and an efficient graduate in a technical branch is assured of advancement to £600 p.a. plus cost of living allowance. Further advancement depends upon the occurrence of vacancies.

The existing set-up includes thirty positions in which maximum emoluments exceed £750 per year. Concerning these thirty officers engaged in technical, clerical and administrative work, it is of interest to note that eighteen hold university degrees, while a further five hold diplomas from technical institutions. No less than sixteen have had the advantage of overseas study and experience. The foundation of a solid team has been laid in most branches and, with reasonable facilities, a successful period of endeavour should lie ahead.

Institute members appointed to senior executive positions in the reorganized Queensland Department of Agriculture and Stock include Messrs. A. F. Bell (Technical Assistant Under Secretary and Director of the Bureau of Sugar Experiment Stations), R. Veitch (Director, Division of Plant Industry), W. G. Wells (Specialist Adviser, Experiment Stations, and Cotton Specialist), J. H. Smith (Officer-in-charge, Science Branch), C. J. McKeon (Director of Agriculture), and D. O. Atherton (at present on war service—Assistant Director of Agriculture), Drs. W. A. T. Summerville (Director of Horticulture) and S. A. Trout (Assistant Director of Horticulture), Messrs. E. B. Rice (Director of Dairying) and H. K. Lewcock (Acting Assistant Director of Marketing and Senior Marketing Officer).

The McCaughey Memorial.

The " Coree " and " Coonong " Research and Training Institute has been established by Messrs. Samuel McCaughey, " Coree ", Jerilderie, and David Roy McCaughey, " Coonong ", Narrandera, as a memorial to the memory of Lieutenant Samuel Michael McCaughey (son of Mr. Samuel McCaughey and nephew of Mr. David Roy McCaughey), who was killed in action on 28th December, 1943, at McCaughey Knoll, Shaggy Ridge, New Guinea, whilst on active service with the A.I.F., and Air Gunner David Leslie Macpherson, R.A.A.F. (son of Mrs. Edward G. Dermer, *née* McCaughey, and nephew of Messrs. Samuel McCaughey and David Roy McCaughey), who was killed on 4th February, 1943, near Macdonald in Northern Australia, whilst on an operational mission against the enemy.

When certain transactions and formalities are completed, the Trust will be the owner of approximately 24,000 acres of " Coree " Station, including the homestead and all station buildings, and the memorial will be on behalf of the McCaughey family.

The functions of the Trust will be the promotion, encouragement and advancement of education for the benefit of the pastoral and agricultural industry generally by means of research and the training of specialists, etc., the Trust being empowered to cooperate with any Australian university or educational or scientific institution for the furtherance of the above objectives.

The Trustees have been given wide powers to enable the Trust to function with maximum advantage. It may be some little time before the Trust can operate with full capacity, in so much as there will be a good deal of establishment work to be undertaken and adjustments made to enable the residue of " Coree " Station to be worked to the advantage of the Coree Pastoral Co. Pty. Ltd. (in which members of the McCaughey family are the only shareholders).

The Trustees are Mr. Frank Young (Chairman and Managing Director of the Commonwealth Wool and Produce Co. Ltd.) and Sir Henry Edward Manning, K.C., M.L.C. At a later date it is intended that Mr. David Roy McCaughey, " Coonong ", Narrandera, will become an additional Trustee.

The Riverina district of New South Wales, in which the fine pastoral property " Coree " is situated, has long been renowned as a centre for stud sheep breeding and for the contributions it has made to the improvement of the merino sheep. It will be interesting to see how the Trustees interpret their important trust.

Winter School in Soil Science.

About 120 persons attended the Winter School in Soil Science which commenced on 20th August at the Waite Institute, under the auspices of the University and C.S.I.R. The visitors came from a number of State and Federal departments and the universities. All the State Departments of Agriculture and soil conservation bodies were represented. Foresters and

engineers concerned with soil problems were present in some numbers. There was one visitor from the D.S.I.R., New Zealand.

Talks were given on some of the fundamentals of soil science, with discussions on soil classification, soil fertility, soil erosion, irrigation, drainage, land use and other subjects. A full account of the proceedings will be given in the December issue.

Schools for Farmers.

One of the bright spots in agricultural extension work in Australia is in the Murrumbidgee Irrigation Area, where two years ago a special extension service was inaugurated for the intensive education of farmers in correct irrigation practices. The most successful means of demonstrating to and instructing farmers is through their own community organized groups. The landholders see their need for information on soils, farming practices and general horticultural matters to enable them to maintain a satisfactory level of production. To meet these needs two short schools, each of six sessions, were organized by growers' committees. One for the Corbie and Merungle Hills Extension Group at Leeton in March, 1944, and one for the Ballingall Extension Group at Griffith in June, 1944.

The lecturers were drawn from the soil and irrigation extension services, C.S.I.R., the Department of Agriculture and the Water Conservation and Irrigation Commission. The subjects dealt with included soil types, irrigation practices, waterlogging and soil salinity, reclamation procedures, farm design, rooting habits of plants and citrus root stocks. The lectures in broad outline, with a number of questions and answers, have now been issued as a pamphlet entitled " Facts for Irrigation Farmers ", Proceedings of Extension Schools for Farmers, M.I.A. The publication affords a useful summary of information applicable on the M.I.A. generally, and particularly to the hill slope types of country with which two Extension Groups were concerned. It may well serve also as a guide for extension services wishing to apply the same idea.

Book Reviews

ROOT DISEASE FUNGI, by S. D. Garrett, M.A., D.I.C.

(177 *pages*, 9 *figures*. *Chronica Botanica Co., Waltham, Mass., U.S.A.* 1944. *Price* $4.50.)

This book is the first volume of a series, Annales Cryptogamici et Phytopathologici, published by the Chronica Botanica Company. It deals with a group of fungi, for which plant pathologists have in general had great difficulty in devising control measures. As stated by the author, the book is not intended as a text-book or comprehensive reference book on all root-infecting fungi and the diseases which they cause, but rather as a treatise on the ecological relationship between parasitic soil fungi and their habitat, particular attention being paid to root diseases of notable economic importance and measures for their control.

The first three chapters are devoted to a historical review, a discussion of microbiological equilibrium in the soil and the spread of parasitic fungi both outside and within the roots of the host plant. These are followed by three chapters dealing with the influence of environmental conditions, such as temperature, soil moisture, soil reaction, organic content and plant nutrients, on parasitic activity. Included in these chapters are useful reference tables listing diseases which are favoured or hindered by certain of these environmental conditions. Chapter 7 is a discussion on the saprophytic activity of root infecting fungi, from the active saprophytism of the soil-inhabitant class to the limited saprophytic survival in invaded tissues of the soil-invader class. Chapter 8 is devoted to dormancy and the importance of resting spores and sclerotia.

The final seven of the fifteen chapters are concerned with control measures ; three of these deal with field crops, three with plantation crops and one with glass-house crops.

The subject matter is well arranged and the book is provided with a bibliography listing 451 papers, a general index and an author index. The addition of summaries to certain of the sections and chapters would have been an improvement.

The book is a welcome addition to mycological and plant pathological literature in that it brings together the results of many research workers and arranges them not according to the taxonomic classification of the causal organisms, but according to the relation between the fungi, their hosts and the soil environment. It is a book which should be read not only by research workers investigating specific root disease problems, but also by all plant pathologists and others interested in the control of plant diseases.

R. D. Wilson.

LIVESTOCK IMPROVEMENT, by J. E. Nichols.

(*Oliver & Boyd, Edinburgh. Price*, 10/6 *sterling*.)

The teacher of animal genetics, to a greater extent than those of other subjects, is confronted with a dearth of suitable textooks. Although the mechanism of heredity is alike in both plants and animals, the problems and methods differ considerably. The plant breeder has often been able to breed along simple Mendelian lines. He has absolute control of his material ; it is not

mostly in the hands of other breeders. He can work with thousands of individuals. He can cheerfully discard the lot if he wishes to do so; the individual plant is of no appreciable commercial value. If he succeeds in producing one plant that measures up to his ideal, he can so multiply it that in a few years all demands can be met. For these reasons plant breeders have been able to achieve more than the animal breeders. To begin with, animal breeding is mostly in the hands of people who are untrained in genetics. Nobody has dared to suggest that the Government should have a virtual monopoly of stud animal breeding as it has of stud plant breeding; yet animal breeding demands no less knowledge or training than plant breeding. The scientific worker in animal breeding is lucky if he can work in hundreds, let alone thousands. The experimental material is so much more costly. Each individual has a substantial commercial value and even in scientific work on animal breeding the individual animal is frequently expected to pay part of its own way.

A further difficulty is created by the slow rates of reproduction of large animals. The experimentalist may succeed in breeding an outstanding herd or flock, but the benefits of the particular improvement cannot be distributed rapidly and in fact, are often quickly dissipated by outcrossing, the common method of breeding.

Self-fertilization, which constitutes a powerful tool in the hands of the plant breeders, and is especially valuable in maintaining the purity of an improved line in plants, is denied to the animal breeder.

Despite the pretty pictures of colour inheritance with which the writers of early textbooks on animal breeding decorated their pages, simple Mendelian breeding is of little consequence in animals. The economic characters are inherited mostly in multifactorial or polygenic fashion. The modern approach to animal genetics is essentially a statistical one. The characteristic expression of polygenic inheritance is in the normal distribution curve.

Of the textbooks available, Lush's " Animal Breeding Plans " represents the first and probably still is by far the best general exposition of the modern approach, but Lush's book is not suitable as the sole text. It was never intended that way. It is primarily an advanced text for " students who have already had courses in genetics, embryology, anatomy, physiology, herd-book study, history of breeds and livestock judging ". Further, it is too advanced in many parts for the student who lacks knowledge of higher mathematics and statistics. At the other end of the scale is Hagedoorn's " Animal Breeding ". This does not presume to be a textbook. It is the book of an enthusiast, a progeny-test enthusiast, who writes for breeders. Whatever faults Hagedoorn may have as a textbook, it has served its main purpose well. It has done more than any other book to disturb the traditional views of breeders.

Hammond's " Farm Animals ", though not a genetical textbook, supplements the two already mentioned. Its importance lies in its description of Hammond's work on the influence of environment on growth and development.

This new book by Nichols fills a useful place in presenting in simpler form than Lush the modern approach to animal genetics. The author sets out to bridge the gap between formal genetics and the actual practice of animal improvement. He does that well up to a point. He is closer to the practical problems than Lush and he commands a welath of illustration for the principles. He lays great stress on the ecologic approach, and this is probably his most valuable contribution. But Nichols does not quite succeed in bringing his subject down to earth. He writes for the student and the teacher rather than the animal breeder. His style, though clear, is unsuitable for the general reader. For the technical reader, Nichols does not displace Lush. The two are complementary.

H. J. Geddes.

SHEEP, by J. F. H. Thomas and Others.

(*Faber & Faber, London. Price 15s. sterling.*)

J. F. H. Thomas says in his preface to this book that he aims " to give a picture of the Sheep and Sheep Farming of Great Britain at the present time " and he succeeds admirably in doing just this. His style is simple and lucid. He has called in the assistance of Martin Jones, M.Sc., Moses Griffith, M.Sc., and A. R. Wannop, B.Sc., each to write a chapter on sheep farming in Scotland, Wales and the Scottish border counties respectively.

This is a book that will be read with interest and enjoyment by all sheep lovers. It contains little of specific interest or value to the Australian " rancher " of merino sheep, although, even he as a sheep lover will get pleasure and interest from this account of the care and management of British sheep based on centuries of tradition, in that rather inclement environment. For overseas breeders of British types of sheep the book is invaluable in that it sketches admirably the characteristics of the numerous British breeds, the environment in which they have developed, and the way in which they fit into the remarkably stable and rather complex organization of the British sheep industry. Moreover, it explains clearly the meaning of such colloquial terms as " gimmers ", " tegs ", " theaves ", " diamond tups ", " heft ", " hirsel ", " inbye ", etc., which are so unfamiliar and confusing to the overseas reader of British stock journals and even to British sheepmen from a district where they are not used. All interested in sheep husbandry and pasture management will find many wise comments running through this book that represent conclusions based on very extensive experience.

The book is up to date in that it describes the sheep industry of Britain after four years of war and the changes in the sheep populations and in the marketing of meat and wool that have taken place during the war. It also mentions cobalt for " pine " and copper for " swayback " and phenothiazine as a vermifuge. In some ways it is behind the literature. It erroneously attributes pregnancy toxæmia to protein deficiency, and fails to mention the merits of B.T.B. and B.K.B. as a dressing for fly strike. It discusses the practice of sheep husbandry rather than the principles and leaves the impression that, although we have something to learn from the British sheepman, he also has something to learn from us.

The attractiveness of the book is greatly enhanced by the inclusion of 44 exquisite photographs.

In dedicating this book " to those men in lonely places, who, with patience and fortitude, have made the care of sheep their life's work ", the author has paid a graceful tribute to the worth and work of the British shepherd. One feels that Australia owes indirectly a debt to those same fine men for her pre-eminence in the sheep world.

A. M. Stewart.

DARWIN ON HUMUS AND THE EARTHWORM.

The formation of vegetable mould through the action of earthworms with observations by Charles Darwin, with an introduction by Sir Albert Howard.
(*Faber and Faber Limited. Price 8s. 6d. sterling.*)

Darwin's classical book on earthworms, first published in 1881, has long been recognised as one of the most interesting books on soil ever written. Darwin was a keen observer of soil phenomena, and his writings abound in descriptive accounts of soils in many parts of the world, not omitting an account of the laterite of Western Australia which, however, he did not name as such. In those soils in which earthworms play an important part, they are responsible for the constant mixing of the soil layer in which they work with any available organic matter and for the sorting out of coarser from finer mineral matter. Such a mixing and sorting action must tend to maintain a surface horizon fairly uniform in character and of constant depth. To Darwin " vegetable mould " was not necessarily the humified organic matter of the soil but the whole surface horizon with which such organic matter was incorporated. The reprinting of this classic is made the occasion of an introduction to the book by Sir Alfred Howard, in which he characteristically condemns the exclusive use of artificial manures and poison sprays on account of their harmful effect on the numbers of worms in the soil. Although he condemns the Rothamsted tradition in this respect, the study of earthworms at Rothamsted has by no means been neglected, and Darwin himself quotes some observations of Dr. Gilbert. Earthworms are obviously dependent on an external source of organic matter, particularly in cultivated land, and they are very sensitive to soil reaction as has been experimentally shown by O. Arrhenius, being able to live and propagate within a relatively narrow range round pH 6 to pH 7. The scarcity of worms in the alkaline soils of arid regions is well known, and as earthworms are dependent on calcareous glands it is not surprising that they should be rare in naturally acid soils or soils made acid by the use of sulphate of ammonia. Morris, in his examination of the Rothamsted soils, found twice as many worms in the farmyard manure plot of the Broadbalk wheat field as in the unmanured plot and in Barnfield very few indeed in the mangold plots receiving no farmyard manure. The most recent investigation of the chemical composition of worm casts, that of Lunt and Jacobson of Connecticut, shows that the casts are richer in organic matter and have higher pH values than the original soil and attribute the changes in composition as due chiefly to the intimate mixing of plant and animal remains with the mineral soil in the alimentary system of the worm and to the subsequent digestive action. The parallel action of termites in modifying the soil would be of some interest in parts of Australia, but so far little opportunity has been presented for detailed study. In Thailand, Pendleton has recently described the accumulation of free calcium carbonate in soils derived from termite mounds even when these are derived originally from soils which are relatively acid, at least in the surface layers.

To return to Howard's main thesis that the continued use of chemical fertilisers can only have harmful results on the soil in the long run ; there are many parts of the world, including extensive agricultural tracts in Australia, where the use of compost and farmyard manure is out of the question. To most Australian farmers, however, chemical fertilisers imply superphosphate only with or without accessory trace elements, and as a result few appear to realise the great importance of nitrogen in the farm economy. In the reviewer's own experience of the effect of composts, it is the nitrogen supplied that is all-important. The deterioration of soil structure which has been noted in continual cultivation cannot in experience be overcome by the use of green manures, and it is probable that some system of ley farming will have to be developed adapted to Australian conditions which will give time for the structure-building property of undisturbed grassland to exert itself.

J. A. Prescott.

Obituary

PROFESSOR JAMES DAVIDSON.

Colleagues and other intimate friends find it hard to realize that James Davidson has departed from us. He died in Adelaide on August 13th after a brief period in hospital. Davidson was born in Cheshire, England, in 1885. He graduated from Liverpool University in 1908 and received his M.Sc. in 1910. After a period as Wolfe Barry Research Student at the Imperial College of Science and Technology, London, he was awarded a research scholarship in zoology by the Ministry of Agriculture.

Davidson's early research work on the biology of ticks and insects was done in England in association with Prof. G. H. F. Nuttall and Dr. L. E. Robinson; in Germany at the Royal Biological Institute, Berlin—Dahlem; with Prof. A. Berlese in Florence, and Prof. P. Marchal at the National Institute for Agriculture in Paris. Davidson often spoke of the debt which he owed these men. The degree of D.Sc. was conferred on him in 1915.

Prior to this, however, in August, 1914, he had enlisted in the Royal Fusiliers but soon received a commission in the Royal Irish Rifles. Shortly afterwards he was transferred as a captain in the R.A.M.C., where his special knowledge secured due employment. He took charge of special units concerned with insect control, sanitation and, later, transfers of prisoners of war. In 1919 Davidson was appointed Chief Assistant in Entomology at the Rothamsted Experimental Station and remained there for nine years. During this period his attention was largely devoted to the biology of the Aphidæ, a subject which he dealt with in a monograph and several scientific papers.

During these investigations an incidental observation provided what has since proved to be a very fruitful clue. Growing broad bean plants in water culture solutions, Davidson noticed that the addition of a small quantity of boric acid produced a strikingly superior growth in plants so treated. Results from the development of this clue at Rothamsted and elsewhere, as it applies to the use of boron, are well-known, and it is hard to say how far these developments have been responsible for the general and widespread interest in " minor element " requirements which have since been awakened.

In 1928 Dr. Davidson came to Australia to take charge of the Department of Entomology at the Waite Agricultural Research Institute. In 1937 he was appointed Waite Professor of Entomology, the first chair of its kind in Australia. A wide field in a new world called for a broad outlook and Davidson soon brought his mind to focus on broad and important problems of insect ecology and the influence of weather and climate on the abundance and distribution of insects. Fine qualities were brought to this task. In all things, J.D. had the most ardent passion for truth and accuracy, and strove continually after precision in thought and expression. Nothing was more distasteful than " woolliness " and all who worked with him were inspired by the standards he set. He was able to make progress in a field where measurement is not easy because he could recognize and concentrate on broad principles and avoid irrelevant detail.

In his work both with insect development in relation to temperature and with the growth and decline of animal populations, he found the principle of the logistic curve useful and his handling of these expressions together with his general bioclimatic work earned him a world-wide reputation.

James Davidson's scientific outlook was an inspiration to his fellows and since this outlook was wedded to humility, tolerance and a charity for the weaknesses of his colleagues, he held a warm place in their regard. His passing is a severe loss to the cause of biology in Australia and a sad blow to his many friends.

Personal Notes

Major J. H. Simmonds, of the Queensland Branch, has received the M.B.E. for services in Papua and New Guinea. Major Simmonds accompanied the first troops into Madang and Alexishafen, and was responsible for malaria control.

F./Sgt. W. A. H. J. Horsley, R.A.A.F., Agrostologist in the N.S.W. Department of Agriculture, formerly reported as P.O.W. in Germany, is now reported safe.

Pte. H. R. Richardson, A.I.F., Plant Breeder in the N.S.W. Department of Agriculture, formerly reported P.O.W. in Germany, is now reported safe.

D. H. Case, formerly of Pacific Potash, has been released from R.A.A.F. and has joined the Department of Commerce and Agriculture, Sydney office.

D. S. Jones, released from R.A.A.F., has rejoined the N.S.W. Department of Education and is teaching at Goulburn High School.

Major A. N. Johnston, A.I.F., former lecturer at Hawkesbury Agricultural College, has been in Sydney for some time giving course work in entomology at the School of Tropical Medicine.

Dr. E. T. Edwards has resigned from the N.S.W. Department of Agriculture to edit the new agricultural supplement of *Smith's Weekly*, " The Farm, Farmer and Farmer's Wife ".

P. Skerman has resigned from a lectureship at Hawkesbury Agricultural College to take up duties in the Department of Lands, Queensland.

D. B. Duncan, holder of the University of Sydney Pawlett Scholarship, has left for Iowa State College, U.S.A., to pursue an advanced study of mathematical statistics.

Dr. Lilian Fraser has accepted N.S.W. Sub-Editorship of the *Journal of the Institute of Agricultural Science* vacated by H. Parry Brown.

A. J. Anderson, stationed hitherto at the Waite Institute, has been transferred to the staff of the Division of Plant Industry, C.S.I.R. He will later take up his headquarters at Canberra.

R. F. Williams, Assistant Plant Physiologist at the Waite Institute, has been appointed Assistant Research Officer in the Division of Plant Industry, Council for Scientific and Industrial Research. He will conduct plant physiological investigations on vegetable crops at Griffith.

S./Ldr. L. A. T. Ballard, R.A.F., has accepted the appointment of Plant Physiologist at the Waite Institute, though it is not expected that he will be demobilized for 15 to 18 months. S./Ldr. Ballard graduated in agriculture from the Melbourne University, and after a term at the Waite Institute was awarded an 1851 Scholarship, in 1934. Subsequent to working at Cambridge and prior to taking his part in the British war effort, S./Ldr. Ballard lectured in botany at Trinity College, Dublin.

P. G. Schinckel has been appointed Lecturer in Animal Husbandry and J. V. Mertin Assistant Plant Breeder, at Roseworthy Agricultural College.

N. S. Tiver has been discharged from the navy and appointed Assistant Agronomist at the Waite Institute.

O. Bowden has been appointed Supervisor of Land Development in the Department of Lands, South Australia.

Yvonne Aitken, who has done research work for several years at the Melbourne University School of Agriculture, was recently appointed to the University teaching staff.

N. McNeill, G. H. Neil and V. J. Williams, student members of the W.A. Branch, who entered the services at the conclusion of the first year of the degree course, have resumed their studies.